ENGINEERING AND MINING JOURNAL

A McGRAW-HILL PUBLICATION

DECEMBER 1960

PRICE ONE DOLLAR

FOUNDED 1866

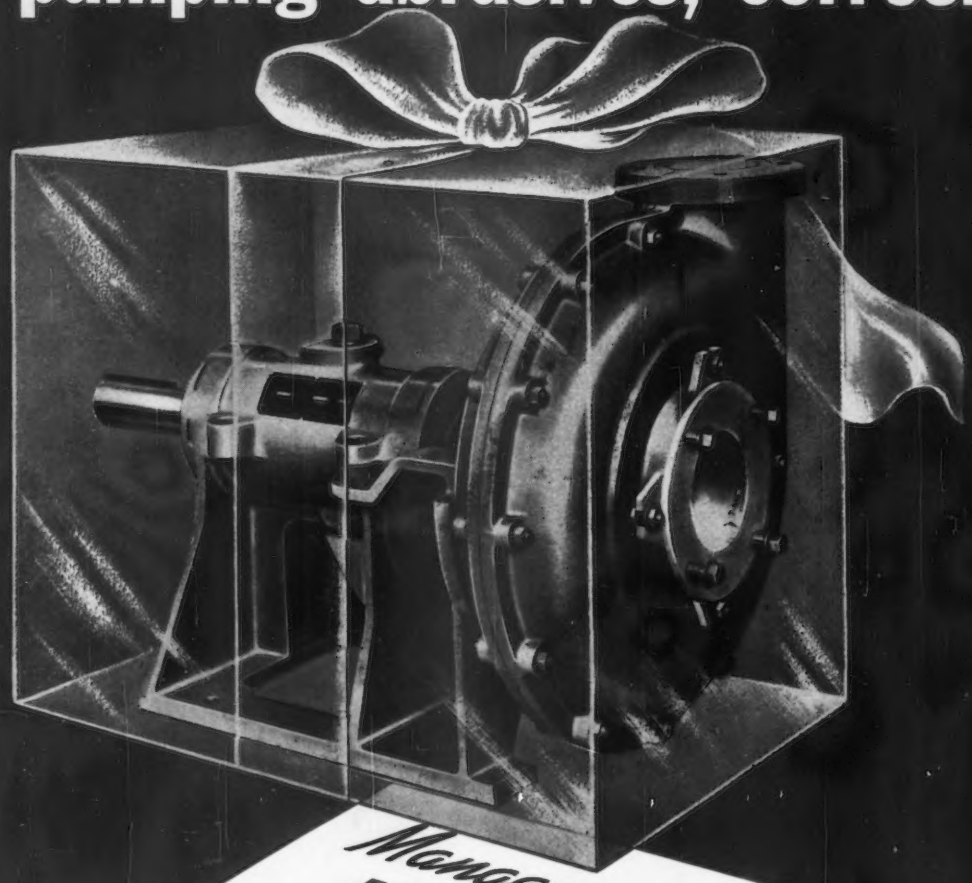
SPECIAL REPORT

DIRECT REDUCTION OF IRON ORE

. . . . . intensely researched, now moves into commercial application.

p 83

For pumping abrasives, corrosives



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A year was necessary to film, at intervals, the operations you will see in this actual case history of a change-over to S-D Automatic Overlapping Cars. It shows operations BEFORE . . . DURING . . . and AFTER conversion to a main line haulage system that reduced cost to the minimum and provided Non-Stop Maximum Haulage — with fewer men and less equipment. It further features Automatic Loading Stations, what they do and how they operate in this mine. This documentary 22-minute color and sound 16mm movie is available now for your review. Ask us to mail this film to you for showing to your operating personnel . . . or, ask us to have one of our representatives bring projector and the movie to show for you. Write or call us today. Use coupon below to make mail request.

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KNOXVILLE, TENNESSEE

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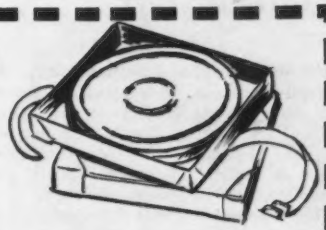
☐ We have sound projector. Please mail film "Non-Stop Maximum Haulage" to us for review and study.

☐ Please have your representative contact me. We would like to have him visit us to show the movie "Non-Stop Maximum Haulage".



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Mining Calendar

National Conference on Water Pollution, Public Health Service, Washington, D.C. Dec. 12-14 1960

Light Metal Industry Symposium, National Metallurgical Laboratory, Jamshedpur, India, February 1961

International Symposium on Mining Research, University of Missouri, Rolla, Mo., Feb. 21-25 1961

AIME annual meeting, Chase-Park Plaza and Ambassador Hotels, St. Louis, Feb. 26-March 2 1961

Western Mineral Congress, Ambassador Hotel, Los Angeles, March 20-24 1961

Fourth Symposium on Rock Mechanics, Pennsylvania State University, University Park, Pa., March 30-April 1 1961

International Symposium on Agglomeration, Philadelphia, April 12-14 1961

Wyoming Mining Association Convention, Rawlins, Wyo., April 21-22 1961

AIME-Southwest Mineral Industry Conference, Stardust Hotel, Las Vegas, Nev., April 24-25 1961

High Temperature Materials Conference, Cleveland Section, AIME, Hotel Pick-Carter, Cleveland, April 26-27 1961

Sixth Annual Uranium Symposium, Grants, N.M., May 12-14 1961

Commemoration of the 50th Anniversary of Froth Flotation in the U.S., sponsored by MBD of SME, Cosmopolitan Hotel, Denver, Sept. 17-20 1961

Northwest Mining Association Convention, Davenport Hotel, Spokane, Wash., Dec. 2-3 1961

Coming Up

Next month—The Viburnum story. St. Joseph Lead Co. is bringing in one of the most exciting projects in the history of lead-zinc mining. The Viburnum project, in Missouri, comprises the latest ideas in design, automatic controls and sampling, and improved efficiency.

The whole story, with flowsheets, plant drawings, diagrams of controls, etc. will appear in next month's issue.

Stealing a march—E&MJ's annual survey and outlook issue, traditionally published in February, has also contained our census of projects under way, in the planning stage, and recently completed.

That section, along with annual reviews of mining and processing technology, will appear in the January issue, a full month ahead of usual. The commodity reviews will still appear in February.

94th YEAR OF PUBLICATION

ENGINEERING AND MINING JOURNAL

DECEMBER 1960

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Belt gets up and goes— unloads ore ships in a hurry

After 9 million tons, B.F.Goodrich belt still going strong

At this pier, iron ore is unloaded from ocean-going freighters at a 2000-ton-an-hour clip. The conveyor belt rushes it up to waiting railroad cars. The whole system works so well that even the largest ore-carrying vessels can be emptied in less than 24 hours.

To stand the heavy loads, the speed, and to insure continuous operations, the engineers in charge selected a B.F.Goodrich conveyor belt. Special chemicals, developed by BFG, were added to the rubber to keep the belt "live" and elastic, help it resist the effects of air, sun, weather. Patented layers called "breakers" were built into the belt to increase impact resistance.

The trouble-free performance of the B.F.Goodrich belt has helped make this B & O Pier, Curtis Bay, Maryland, one of the biggest, fastest and most efficient ore-handling facilities on the East Coast. And after carrying nine million tons, the BFG belt is still in good condition.

But good as this record is, chances are that it will soon be bettered because of the improvements that are constantly being made in B.F.Goodrich belts. In recent years, for example, the use of improved rubber compounds and stronger fabrics has resulted in belts that can carry heavier loads farther and faster than ever before, and last longer doing it.

B.F.Goodrich distributors have full information on the belt described here. And, as factory-trained specialists in rubber products, they can answer your questions about the many rubber products BFG makes for industry. *B.F.Goodrich Industrial Products Co., Dept. M-921 Akron 18, Ohio.*

B.F.Goodrich

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Articles in this issue of

ENGINEERING AND MINING JOURNAL

Continued from p 2

83 **Iron — How Is Direct Reduction Doing Commercially?**

Here's a summary of what has happened so far in the attempts of many iron producers to develop economic ways to reduce iron ore to metal, with a look at why these people are not satisfied to leave the job completely to the blast furnace, the "old reliable" workhorse of the iron industry. The blast furnace is not by any means out of the picture; in fact, it's getting bigger and more efficient all the time. But it's grown so big and expensive that only the giants can use it. For many years there have been attempts to produce iron successfully by other means, and some alternative processes have operated commercially for years in other parts of the world. Within the last decade, direct reduction processes have planted their feet commercially in North America; and though no revolution is in prospect, they seem determined to continue here, and to grow.

This article surveys the iron picture, pointing out why so much attention has been paid to direct reduction lately. Starting with those processes that are now paying their way in plants on this continent, it describes the most prominent techniques and tells where each one of them stands at this time. It goes on to report the apparent concensus of iron people as to the pros and cons of direct reduction, where it probably will and won't succeed, and what questions the iron man wants to see answered before direct reduction moves into the major leagues. To fill you in on some of the technical problems the iron metallurgist faces, it reviews some of the chemistry of the iron furnace. To the miner and the nonferrous man watching the iron scene from the sidelines, it tries to show what their ferrous brothers are up to. Perhaps some of the iron men's solutions may point the way to new approaches for the nonferrous metallurgist.

100 **Two New Aluminum Projects Are Progressing**

Expanding development of power and bauxite deposits in Australia and in Ghana are moving nearer to fruition. In Australia, Kaiser Aluminum and Consolidated Zinc Corp. will begin construction of a power plant and reduction works in New Zealand, and mining of bauxite on Cape York in Australia.

In Ghana, the long-studied Volta Project of Kwame Nkhrumah may be coming along, thanks to a consortium of major U. S. and Canadian aluminum producers and the hoped-for release of funds. The latter is the only remaining obstacle, and, with reassurances by the Nkhrumah government that stability will continue in the new African nation, the aluminum firms expect to open the area.

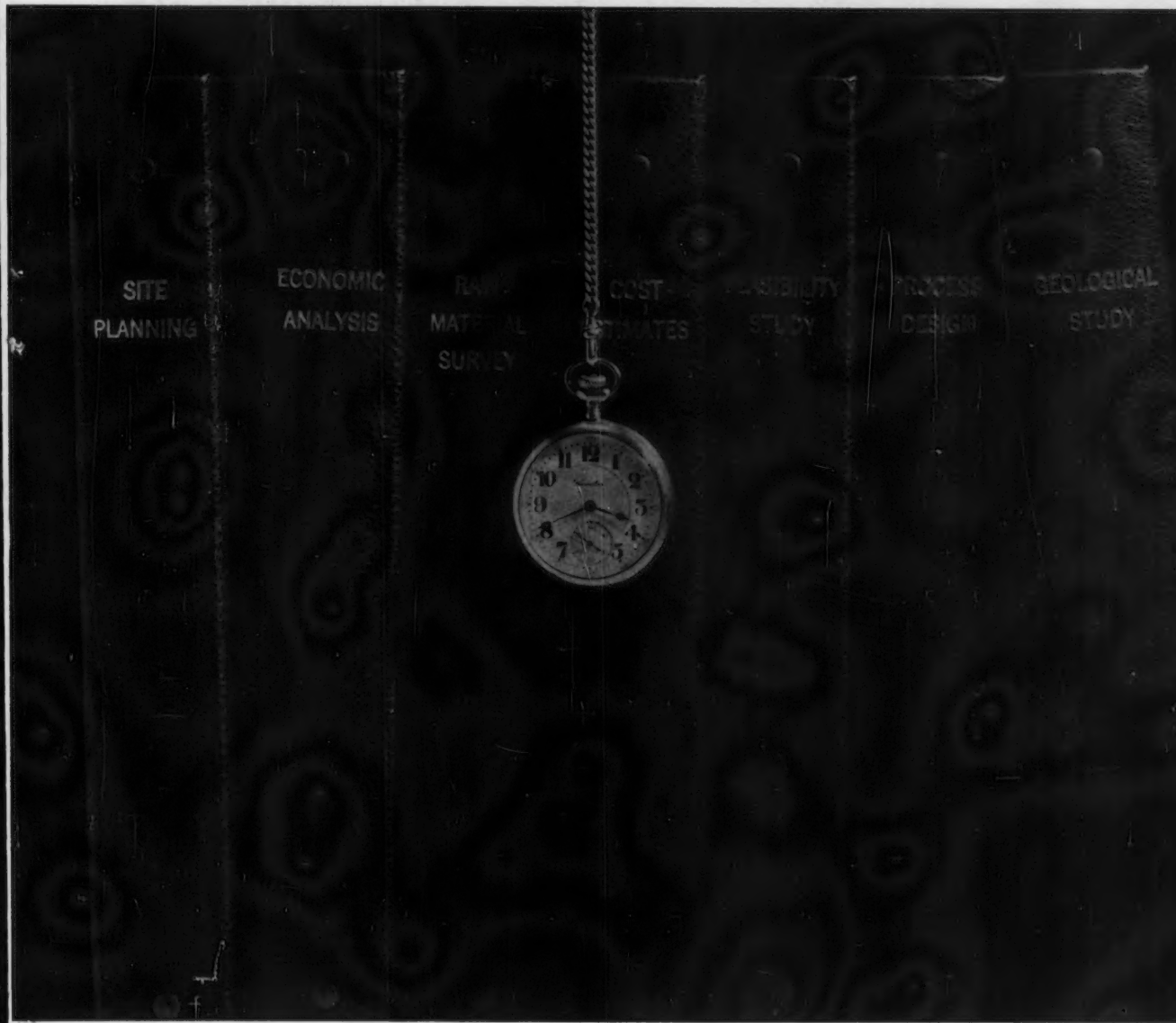
101 **AMC's Technical Sessions — More from Las Vegas**

A continuation of E&MJ's coverage of the AMC Mining Show, with further excerpts from papers presented at the biggest and best mining exposition in the Congress' history. The first part of our coverage appeared last month, beginning on p 24.

106 **Hauling Borax Ore Out of the Pit — by Conveyor Belt**

Careful study of haulage economics, combined with precise engineering, has led U. S. Borax & Chemical Corp., of Boron, Calif., to convert its ore removal methods from trucks to a belt which lifts ore material 315 ft on an 18° incline.

Pre-Engineering by **KAISER ENGINEERS** answers basic plant expansion questions...



Timely? Many complex factors shape the final decision to proceed with your expansion plans...and timing is an important one. Independent analysis of all aspects of your proposed program is the *Pre-Engineering* service offered by Kaiser Engineers. The studies and evaluations furnished by KE Pre-Engineering represent only one phase of total KE services. Kaiser Engineers is an experienced designer and builder of all types of facilities for the Minerals industry. From Pre-Engineering through design and construction, Kaiser Engineers provides complete, one-company service and ingenuity based on years of experience.

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ENGINEERING AND MINING JOURNAL

Ye Christmas Greetings

Good Wenceslas, when he was king
Did vittles to his neighbors bring.
Had we his larder and his freezer
We'd emulate that fine old geezer,
But, lacking his royal wheys and curds
We must fall back on simple words
And hope that we can make them rhyme
To wish you well at Christmastime.

We wish Jim Cox a Yule-terrific,
Add Ernie Thurlow, North Pacific.
And may it be the best of all
For A. Payne Kibbe and Nels Stahlheim, Fred DeVaney, Larry Roe,
Elmer Jones at St. Joe, Mo.,
Stuart, Herb and Williston, Sam,
Ralph Wilpolt, Tom Gillingham.

Sing Noel and sing Greensleeves
For L. L. Huelsdonk, Charlie Cleeves
Sunshine's Edgar, Tsumeb's Boyce,
Vitro's Hotchkiss. And give voice
At the party we will pitch
For A. J. Thuli, Cecil Fitch,
H. S. Woodward, Nipton, Cal.,
Bartlett, Bill, and Teske, Al.

Let English carols now be heard
For Maxwell Norman of Camp Bird.
In fact, let's have all twelve days sung
For Robert Linney, Howard Young,
Russ Woods and Adolph Mitterer,
John Bley and C. Hall Carpenter,
And for Fay Bristol in the north,
Allan Jones, Bill Dyrenforth.

C. F. Beukema, greetings give
From Oliver Iron Mining Div.,
To Hans Ahlmann up in Sweden,
Ingemar Pousette, Boliden,
Dworshak, Hank and Moffett, Harry,
Chadwick, Jack and Fisher, Larry,
Gordon Weller, Severn Brown,
And Hal Krueger, Fredericktown.

The tree we will caparison
For Cleveland's H. S. Harrison,
For Feierabend's newest kid
And for Professor Janelid.
To all of Utah's mining gents,
Norman Williams, Sam Arentz,
S. K. Droubay, greetings take.
And add J. P. O'Keefe, Salt Lake.

Use Joe Clark's dredge in Kansas C.
To fetch gifts for Bill Boericke,
Charlie Schwab, Newell Appleton,
Mrs. and C. Jay Parkinson.
All the good cheer in the best book
Send Mitch Melich and Miss Westbrook.
And conjure obsidian-bloomin' deserts
For Mr. and Mrs. Jason Everts.

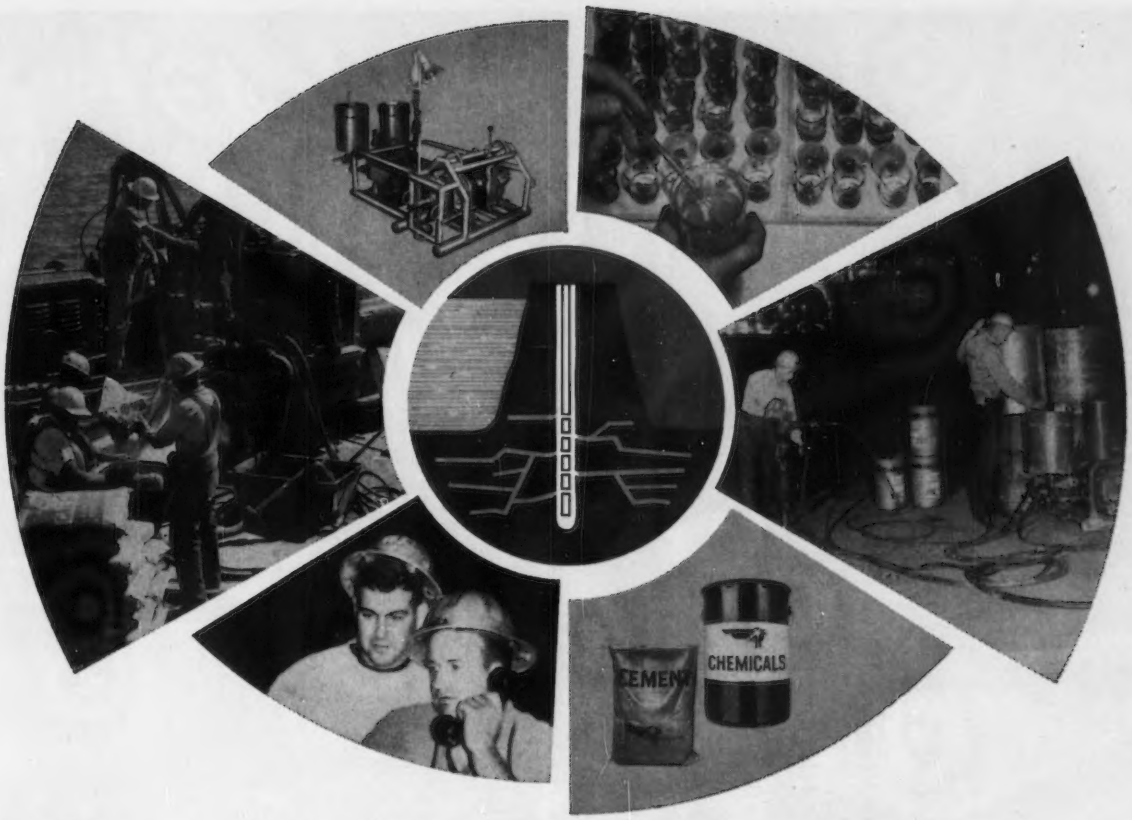
Plus the Wilsons, Forbes and Clark,
Ditto Cranmers at New Park
And Frank Thurston, Thetford, Q.,
Profs—Margolin (NYU)
Schlechten, Pfleider, Hartman, Kerr
And McKinstry. Greetings to Sir
Ronald Prain and Pollock, Clem,
Don Irving of USBM.

Join us for the celebration,
Weeds and Jacobs (Inspiration),
Kleins (the Golden Cycle mill)
Green and Funnell (Broken Hill),
The Johnny Wise's (Colorado),
D. L. Chilcott (Eldorado),
Fritz McGonigle (Howe Sound).
Send Bill Agocs rich new ground.

The sleigh is loaded. Put some more on
For Wamsley, Cooper, down at Boron.
More of the same for Pat O'Neill,
Barney Haffner, Soapy Casteel,
Myron Sisson, CF&I,
Asarco's Mann (that's Victor I.)
Bert Millar and Dunlop, Jack,
Hugo Johnson and Al Hack!

St. Nick has leave to overpark
At Boshkov's house, and with Vint Clark,
Ray's Stan Johnsen, John Reed, too,
Frank Marr and Dr. Toby Yu,
Equally with Evan Just.
Fill Merritt's stocking fit to bust.
Distribute unconfinéd joy
To Sweet Avonne, the girls, and Roy.

And now, again, we near the end
Of this poor labor with a friend—
Or five—or fifty—without mention.
Each year, in spite of our intention
We reach the end of this short list
And find a lot of people missed.
To them, good health, good times, good cheer!
And to you all—a grand New Year! —DPE



FULL SCOPE OF SERVICE

Halliburton *Full Scope* Pressure Grouting Service offers a balanced selection of the best grouting methods and materials available today. To give you the complete picture of the many benefits of this outstanding service, Halliburton has prepared a comprehensive grouting brochure which is available now on request. A few of the advantages offered by Halliburton Pressure Grouting Service, and presented in this brochure, are outlined below.

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CEMENT GROUTING

... with Halliburton cements, retarders and accelerators for helping to seal large fissures and solution channels in water-bearing formations ... and special water-reactive cement grouts for use where troublesome water flows are encountered. These products — together with Halliburton research and know-how — give the greatest selectivity available for choosing the right grout — light or heavy, and the best setting characteristics — fast or slow.

PUT THESE PRODUCTS AND TECHNIQUES TO WORK FOR YOU. When soil stabilization or water control problems point to pressure grouting ... call on Halliburton ... and Compare the Results!

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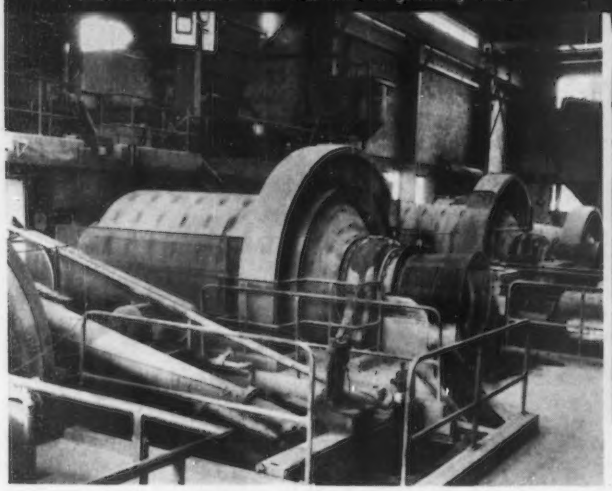
A DIVISION OF HALLIBURTON COMPANY • DUNCAN, OKLAHOMA

Another example of

DORR-OLIVER PROJECT

At The New Jersey Zinc Company's

One of three Dorr 8' x 32' Reciprocating Rake Classifiers at The New Jersey Zinc Company's plant operates in conjunction with rod mills in grinding circuit.



Regrind circuit includes two 12' dia. Dorr Bowl Classifiers (one shown below) for separation of fine sands.

With its world-wide engineering experience in handling virtually all types of solids-liquids unit operations involved in wet chemical, metallurgical and industrial processing, Dorr-Oliver is able to offer a complete project engineering service covering all phases of plant design and construction.

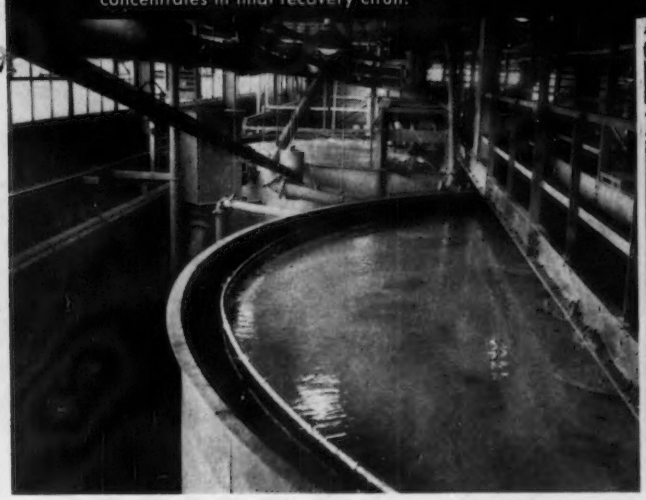
Recognition of the value of this service is offered in the increasing use of Dorr-Oliver project engineering by leading producer companies. One example is The New Jersey Zinc Company's 2500 TPD zinc flotation plant at Friedensville, Pennsylvania in which D-O played a major role in plant component design. In addition to engineering services, Dorr-Oliver also supplied rake classifiers in the grinding circuit, bowl-type classifiers in the regrind circuit, tray thickeners for middlings recovery, thickeners and a disc type vacuum filter in the final recovery circuit.

The scope of Dorr-Oliver engineering services is indicated at right. For specific information on how we can help on your particular project, write Dorr-Oliver Incorporated, Stamford, Connecticut.

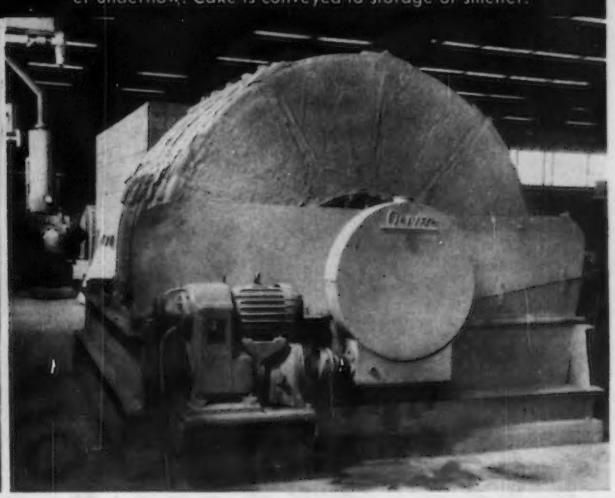
ENGINEERING

2500 TPD flotation plant

35' dia. Dorr Thickeners — 2 units installed — handle concentrates in final recovery ciruit.



8'6" dia. by 7-disc American® filter handles thickener underflow. Cake is conveyed to storage or smelter.



HERE'S WHAT DORR-OLIVER PROJECT ENGINEERING INCLUDES:

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Training of Plant Personnel

Booklet Gives Complete Details and Examples of Installations

A newly published bulletin describes the scope and services offered by Dorr-Oliver Project Engineering, as well as typical plants that have been designed for companies in all parts of the world. Ask for Bulletin No. 8010.

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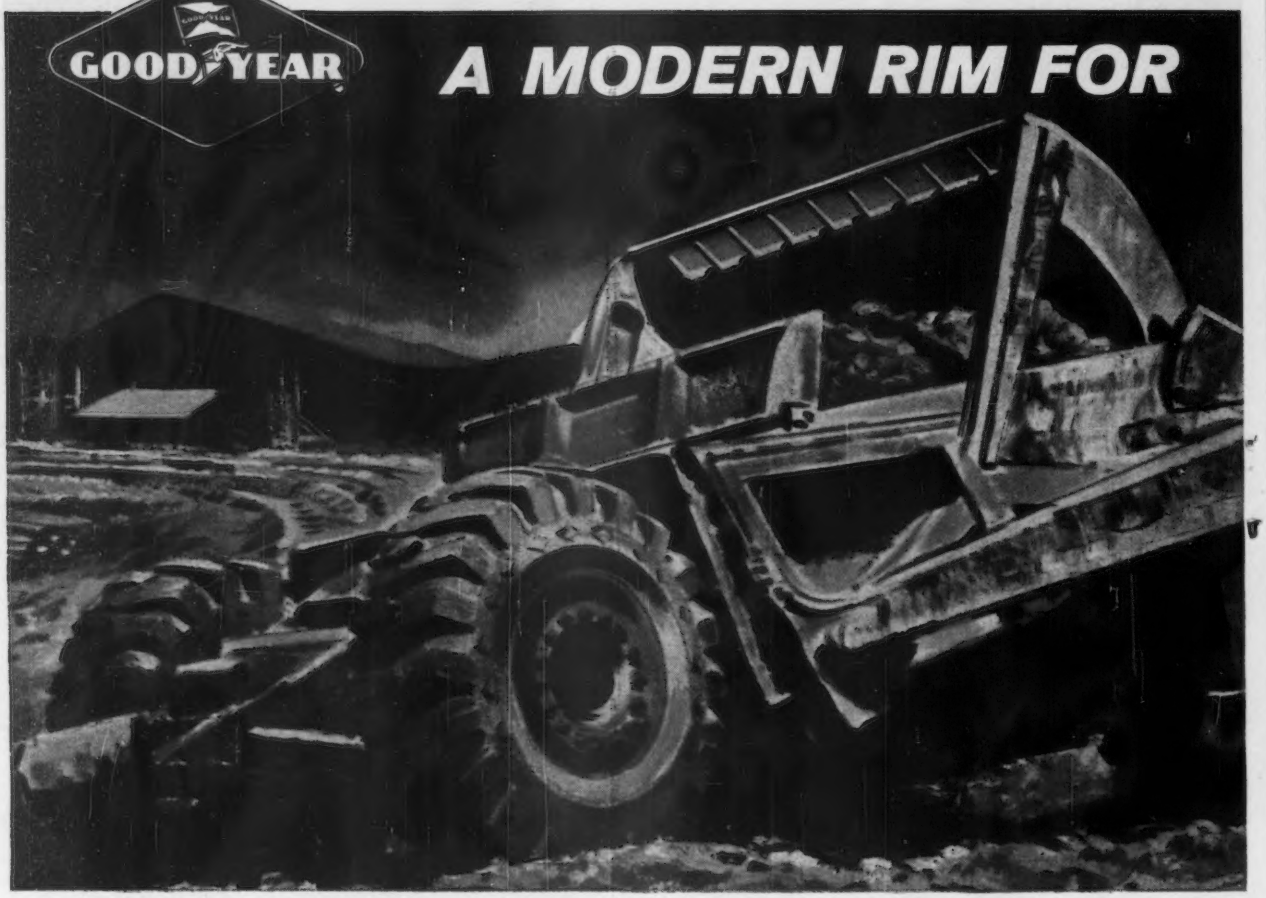
GOODYEAR

A MODERN RIM FOR



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TODAY'S MASSIVE LOADS

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for lasting protection
against rust and corrosion

conditions. And you get the positive air seal provided by Goodyear's famous Tru-Seal.

Goodyear makes rims in widths up to 37″ and in diameters up to 49″. To prevent premature tire and rim failure, it pays to buy and specify rims job-fitted by Goodyear. See your local rim distributor, or write: Goodyear, Metal Products Division, Akron 16, Ohio.

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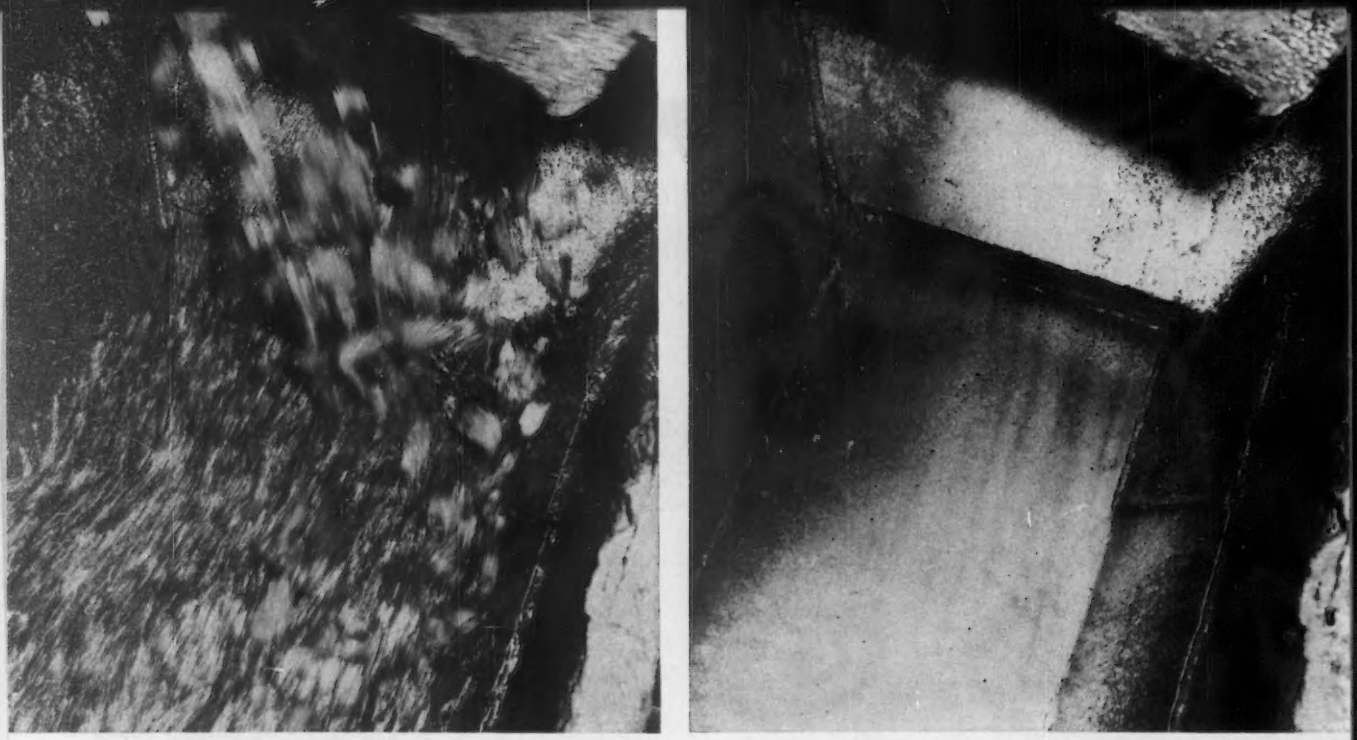
—84 pages of facts and pictures on Goodyear's complete line of rims for every type of vehicle.

YEAR

More tons are carried on Goodyear Rims than on any other kind

Tru-Seal—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio



Processing plant of Oriole mine. USS "T-1" Steel pays dividends in longer chute life, under the grinding action of coal and rock.

Chutes of USS "T-1" Steel outlast others 3 to 1

Coal and rock scraping across a piece of metal are highly abrasive. At the Bell and Zoller Coal Company's Oriole Mine near Madisonville, Kentucky, gravity chutes lasted about three months.

Then Oriole switched to USS "T-1" Steel furnished heat treated to a minimum hardness of 321 Brinell. In this harder condition "T-1" Steel offers maximum resistance to impact abrasion, yet retains toughness and weldability. Their new chutes lasted nine months to a year. The extra cost of "T-1" Steel was wiped out almost immediately by the sizeable saving in the costs of material and fabrication, and by the extended life of the new chutes.

Now, USS "T-1" Constructional Alloy Steel, at 321 minimum Brinell, is used for all sluice and refuse chutes in the Oriole processing plant. More than 3,400 tons of coal and rock go banging and clanging down the chutes daily. Despite impact, abrasion and corrosion, the ⅜-inch-thick plates of "T-1" Steel stay smooth and clean. Coal doesn't clog the chutes.

Other uses where "T-1" Steel saves money. "T-1" Steel's great strength (100,000 psi minimum yield strength), its resistance to impact abrasion and its toughness, even at 50 below zero, make it truly mining's metal. Shovel buckets can be built larger and lighter to scoop more load, truck bottom plates take more battering when made of "T-1" Steel and last longer. Continuous miner front ends, conveyors, vibrator frames—all withstand punishment better and reduce maintenance costs when made of USS "T-1" Constructional Alloy Steel.

United States Steel makes steels of high strength levels for a wide variety of applications: USS "T-1" Steel (100,000 psi minimum yield strength), USS COR-TEN, USS MAN-TEN, USS TRI-TEN brand steels (50,000 psi minimum yield point), in addition to a complete range of carbon and stainless steels. For more information about USS "T-1" Steel, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

30 MANCHA Storage Battery Locomotives

Meet All Management Demands and More at Eldorado Operation in Canada

When the Eldorado Company planned its Beaverlodge mine in Saskatchewan, mine management looked carefully at available locomotives. Their basic demands were durability for heavy duty service . . . accessible construction for maintenance work . . . and good protection for the motorman. Mancha's *standard design* met these requirements *and more* . . . large motors for good running speeds and no overheating (glass-wound coils on all motors). Cam-actuated controllers to minimize maintenance . . . heavy duty continuous wound resistance for proper acceleration and longer life. Battery boxes constructed to withstand rugged treatment. In addition, exclusive TRACKMASTER design levels off rough track and gives effective braking action at all time. So Mancha it was—and today fifteen 3½-ton Titan AN's service development headings and make up main line haulage trains.

The ability to provide low-cost haulage with the 3½-ton Titans was also true of Eldorado's 14 Mancha Little Trammers. These 1½ ton units were used during the initial development of the underground workings. They proved so reliable that they are still in service for supply work and maintenance crews.

Eldorado is another example of how Mancha provided dollar-saving haulage—Mancha can do the same for you.

For longer secondary hauls requiring greater battery capacity, Eldorado uses a Mancha 5-ton Standard AN.

MANCHA LOCOMOTIVE

DIVISION GOODMAN MANUFACTURING COMPANY

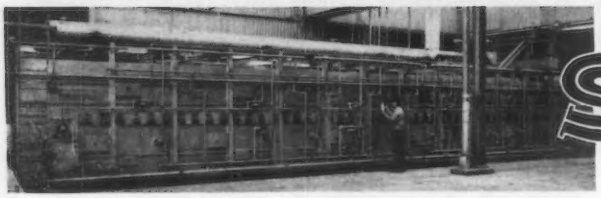
Halsted Street and 48th Place • Chicago 9, Illinois
Cable Address: Mancha, Chicago
Mancha representatives are located in principal mining areas throughout the world.

For iron, carbon and alloy steel castings

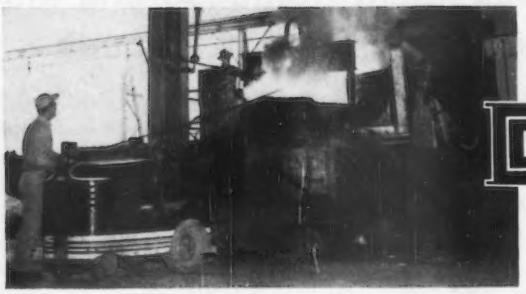
CAPITOL FOUNDRY DIVISION

has unmatched facilities

Quality



Service



Delivery

STEEL CASTINGS Centennial 1861-1961 DESIGN WITH STEEL CASTINGS FOR STRENGTH IN SHAPE

Quality that's inherent in the use of all the latest foundry techniques *plus* experience that stretches back over the years. All melting is performed in electric furnaces.

Service that stems from the operation of a production foundry in Capitol's new and modern 208,000 square foot facilities.

Delivery schedules that are fast and flexible for standard castings as well as specialty items in such metals as gray iron, Ni-hard iron, carbon, chrome-moly, manganese, and Austenitic manganese steel. A-3106A

CAPITOL FOUNDRY DIVISION
POST OFFICE BOX 750
PHOENIX, ARIZONA

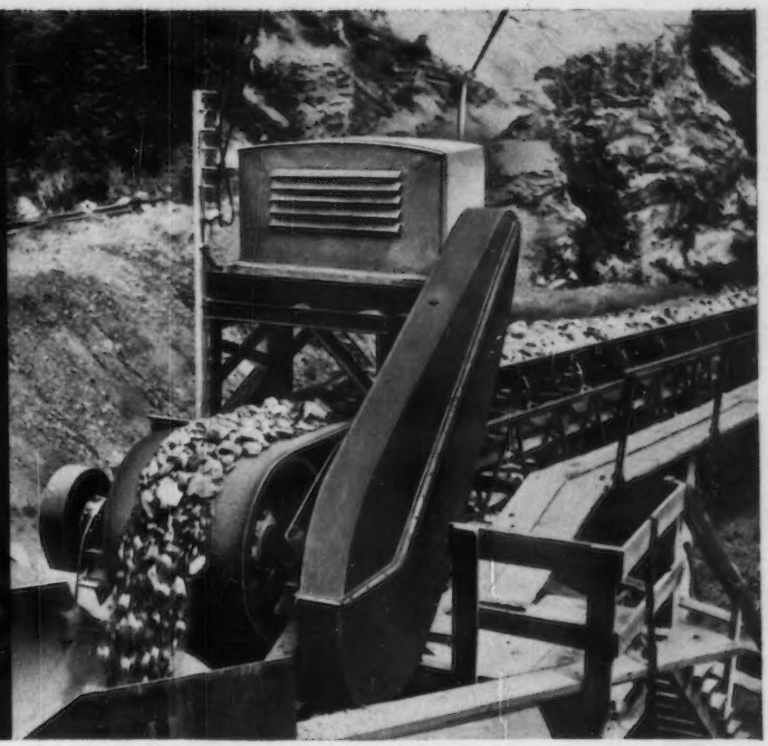
NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

General Offices • Cleveland 6, Ohio • International Division

GOODYEAR

Now...
to remake belting
history..

INDUSTRIAL



...the conveyor belting built for the belt-killers

This is it! New Industrial UNIFLO is the *first* woven-carcass rubber belting specifically designed to make history in hard-rock mining, quarrying, steel mills, pulp mills, foundries and the like.

New Industrial UNIFLO construction is available in a variety of compounds and gauges—including heat- and oil-resistant types. And extensive tests—underground and above-ground alike—have proved its superior capabilities under the toughest operating conditions.

To be specific, UNIFLO construction has . . .

... **proved** its unparalleled resistance to internal rupture caused by trapped material or pulley build-up

... **proved** its tear-resistance 3 times as great as comparable synthetic fabric-reinforced belts—10 times as great as comparable cotton-reinforced belts

... **proved** its excellent impact-resistance

... **proved** its unusually fine cover adhesion and cut-resistance

... **proved** its outstanding troughability and trainability

... **proved** its exceptional edgewear resistance

... **proved** its top-rank fastener-retention—handling wet or dry materials

But these are only the highlights of the great new Industrial UNIFLO Belting. For complete details, check with the G.T.M. – Goodyear Technical Man – through your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Akron 16, Ohio.

GOODYEAR INDUSTRIAL PRODUCTS

GTM-Specified

Industrial UNIFLO conveyor belting for severe above-ground servic

A Seamless, tough covers in a full range of compounds and thicknesses for superior protection against cuts, abrasion, heat and oil

B Single unit carcass of high-tensile, interwoven yarn bonded to the cover under high pressure to give you exceptional strength and fastener-holding qualities – good troughability and trainability

Lots of good things
come from

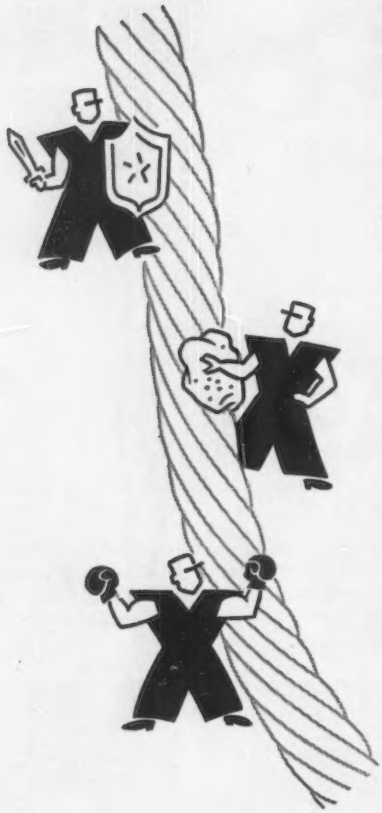
INDUSTRIAL PRODUCTS

Uniflo—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

DOUBLE GRAY-X®

...the wire rope with the

EXTRAS



First — because it's made of *extra* improved plow steel — Double Gray-X has *extra* high breaking strength (15% higher than the catalog breaking strength of non-premium ropes of the same construction). Second — due to Wickwire's new wire drawing process — Double Gray-X gives *extra* long service. Double Gray-X has:

MOLECULAR SHIELD

The use of molybdenum disulphide in the wire drawing results in a shield several molecules thick which lubricates the individual wires and prevents them from grinding against each other when the rope operates. Less internal friction means more rope life.

SMOOTHER WIRE SURFACE

Before Double Gray-X, the most carefully drawn rope wire contained minute surface imperfections. Wickwire's new wire drawing technique improves the surface finish. Smooth surfaced wires provide better resistance to fatigue.

EXTRA TOUGHNESS

Molybdenum disulphide lubricates the wires during the drawing process. Less power is required and less heat is generated during this operation. The original inherent toughness of the wires is better preserved.

Double Gray-X is available in many different sizes and constructions. To reduce your operating costs, you should insist on Double Gray-X. For complete information, contact your local Wickwire distributor. We'll be glad to give you his name and address. Write to Wickwire Spencer Steel Division, Wire Rope General Sales Department, P.O. Box 232, Palmer, Mass.

7953

WICKWIRE ROPE
DOUBLE GRAY-X
DOUBLE GRAY-X
CF&I A PRODUCT

WICKWIRE ROPE

THE COLORADO FUEL AND IRON CORPORATION

DENVER • OAKLAND • NEW YORK

CF&I STEEL

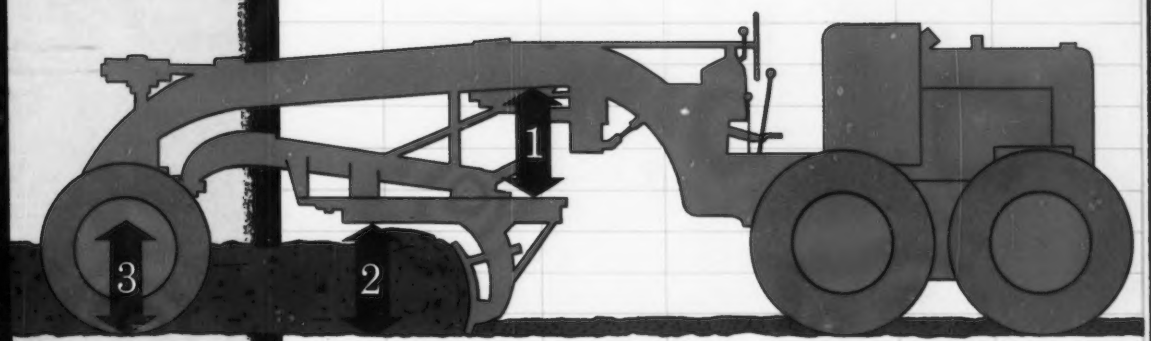
EQUIPMENT COST LEDGER

ITEM	MACHINE	PRICE	OPERATING COST	FUEL	PARTS

See how ALLIS-CHALMERS

3-POINT CLEARANCE DESIGN

helps you get full value from your big motor grader investment



1. Vertical clearance room (1) is designed into Allis-Chalmers graders from the top down. The high-clearance main frame provides full circle and blade freedom and also allows adequate throat clearance (2) under the circle for full ROLL-AWAY moldboard loads without jamming material.

2. Wide-open design concentrates extra clearance (2) from the circle to the blade cutting edge to allow efficient "cut-lift and high-rolling" action of the ROLL-AWAY moldboard. The larger loads you get from this exclusive moldboard use the higher-than-ordinary clearance to maintain a friction-free rolling action.

3. Because the ROLL-AWAY moldboard, along with the extra "working" clearance, can handle extra capacity, the front axle is arched high (3) to let bigger windrows through to the blade. You'll get more work done—easier and faster.

LIFT THE FLAP

ROLL-AWAY is an Allis-Chalmers trademark.

GET 3-POINT CLEARA
....FOR

available only in these two great

ALLIS-CHALMERS motor graders

ANCE DESIGN NOW
FAST, LOW-COST ROAD WORK

Smart buyers are asking these challenging questions

Q If 3-point clearance is so good, why don't others have it?

A To get it, other makes would have to completely redesign their motor graders. Consequently, they use moldboards designed to *push* loads at moldboard height. They can't use a high-clearance system. Allis-Chalmers graders, however, are designed with frames at the necessary height to accommodate the extra load-handling capacity and power-saving advantages of a ROLL-AWAY moldboard—plus circle-to-frame clearance to permit complete maneuverability.

Any motor grader with a lower main frame has to sacrifice the special clearance that makes possible the big production the 45 and 145 give you.

Q Why don't others change their moldboard design?

A Just changing the moldboard won't work because they do not have moldboard-to-circle clearance to accommodate the bigger, rolling loads. To get this clearance would require a complete new machine design—from moldboard through frame.

Q What about visibility?

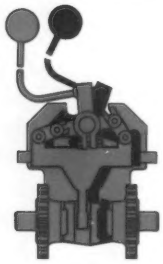
A Allis-Chalmers solved this with a single-member main frame that eliminates split-tail frame gaps. You'll notice, too, the lift cases are mounted close to the frame right over the circle. Control rods are shorter, more compact—don't interfere with operator vision.

But high clearance and big production are only part of the story →

Allis-Chalmers Motor Graders

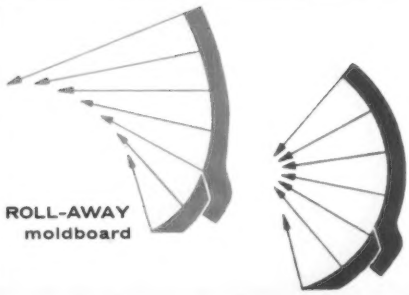
BUILT TO BENEFIT YOU...

Your Operators... Your Mechanics



OPERATOR ACCEPTANCE...

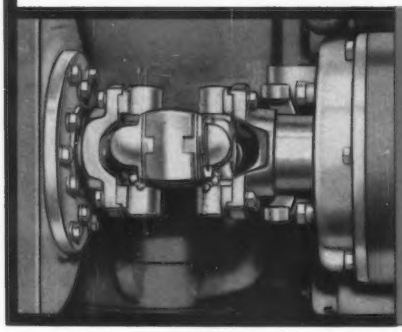
Allis-Chalmers hasn't overlooked the operator. The big deck is cleared for action—with suspended brake and clutch pedals. Toggle-type control levers snap into place —no kickback. Foot pedal changes speed. Comfortable seat and steering wheel are adjustable.



TOP PRODUCTION...

Exclusive design of the ROLL-AWAY moldboard utilizes engine horsepower more efficiently to move bigger loads. Material is lifted and rolled forward . . . each load is live and moving . . . friction drag is reduced. You'll move more material than with any other motor grader of comparable power.

Ordinary Moldboard



SERVICING EASE...

Practical design put all daily maintenance points in the open. True unit construction speeds shop repairs . . . double-yoke universal joint provides handy "disconnect" and easy removal and replacement of major parts without disturbing adjacent assemblies.

Find out for yourself. Your Allis-Chalmers dealer invites you to see these motor graders in action—on your job! Check the high-clearance system and handle the controls yourself—you'll soon know why you can't buy a finer all-round machine. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

A-C ALLIS-CHALMERS

move ahead with

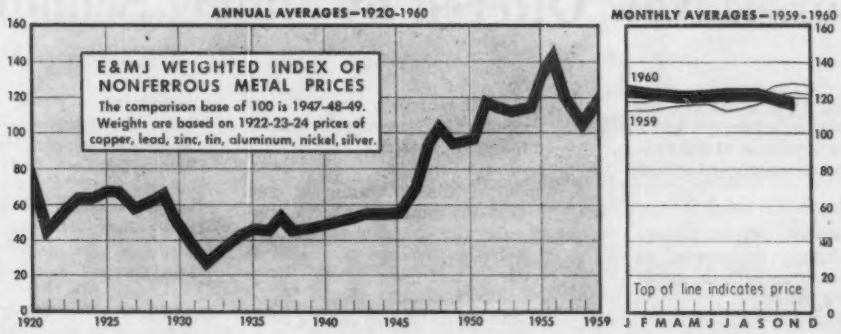
ALLIS-CHALMERS

...power for a growing world

LITHO IN USA D&J-60

E&MJ OUTLOOK

ABROAD



MARKETS

E&MJ's nonferrous metals price index continued its downward trend from October's 122.2 to 120.2 for November. Copper dropped 1c and tin 4c; other metals were unchanged.

Uncertain economic conditions have elicited statements from the industry on the production and marketing prospects of these metals:

Silver—at the present sales rate of from 2 to 5-million oz per month, U.S. Treasury stockpiles will near exhaustion in 20 months. Major silver producers urge governmental adjustment of its policies on 1) the price it pays for silver (this can be legally reset at will) and 2) the volume of silver it sells to industry.

Copper—Sir Ronald Prain, Rhodesian Selection Trust chairman, anticipates world demand of up to 6-million tpy by 1970. Current oversupply will, in his opinion, be curbed by 1963 due to convergence of demand and supply curves (see p 138-139 this issue).

Aluminum—Kaiser Aluminum expects Free-World consumption to double by 1970 (see p 100). However, Nathanael V. Davis, Aluminium Ltd.'s president, has warned against too-rapid expansion of production facilities in advance of demand, lest it militate against growth. He believes only "realistic planning" will restore production-consumption balance.

Lead-Zinc—St. Joseph Lead Co.'s chairman, Andrew Fletcher, looks for increases in domestic lead and zinc consumption of roughly 29% by 1964. His estimate is based on projected population growth. He cautioned that, since lead and zinc have been overstocked by customers during boom conditions and thus not purchased during slack periods, the gains have been, and will continue to be, cyclic.

•

PRICES

McGraw-Hill's Quarterly Machinery New Orders Forecast predicts that capital goods producers' dollar volumes will fall through the first quarter 1961, but turn upward again in the second and third quarters to the same level as third quarter 1960. New orders are expected to improve steadily through 1961, with the earliest "rebounds" expected by metalworking machinery and engines-turbines manufacturers.

•

LABOR

Mine-Mill officials want to negotiate a 35-hour week to help curb dwindling union membership and create more new jobs.

•

AT HOME

Nine Japanese industrialists have confirmed a treaty with Anglo-American Corp. to spend $117,600,000 for iron ore from Anglo-American's Bomvu Ridge property in Swaziland during the next 10 years.

South Africa's Atomic Energy Board is evaluating methods of pacing, or "stretching," the Union's uranium contracts during the expected period of slack demand from 1966 to 1970.

To Mining Engineers—What's Your Opinion On Courses Now Offered by Mining Schools?

MINING ENGINEERS, mine managers and operators and educators attempted to resolve the following problems at the February 1960 session on mining education at the AIME:

1. Are mining schools offering a properly balanced schedule of courses to qualify engineers to cope with the problems of a changing industry?

2. Is industry using its engineers to best advantage, and training them to become proficient managers and administrators?

One of the panel members representing industry suggested that mining schools send questionnaires to their graduates asking them for opinions on the adequacy of courses offered and suggestions for the revision or expansion of the mining curriculum to make it more useful to the practicing mining engineer.

This idea seems to make a lot of sense. Consequently we are requesting our mining engineer readers to fill in the following questionnaire. Results of this survey will be reported to readers, and the mining education session of the AIME which will meet in February 1961. All replies will be regarded as strictly confidential. It is hoped that comments will chart a course of constructive action that might be taken to improve the position of the professional mining engineer.

1. The accompanying table lists the types of courses being offered to mining students. Please check those which have been particularly useful to you.

2. Jot down any additional subjects which you think should be added to present mining curricula:

_____

_____

_____

_____

_____

_____

_____

3. Is a four-year course adequate? Yes _____ No _____

4. If not, should training be extended by:

A. Adding one year? _____
B. Adding two years? _____
C. Offering a three-semester year (i.e. 12 semesters per four-year course vs 8 semesters for current four-year courses.) _____

5. Which of the following do you favor to keep the mining engineer's education in pace with changing technology?

A. Refresher courses by universities _____
B. Seminars _____
C. Training courses by mining companies _____
D. Others, please specify:

_____

_____

6. Should less emphasis be given to practical operating courses such as mining methods, fire assaying, ore dressing, etc., in favor of more emphasis on basic sciences such as physical chemistry, solid-state physics, nucleonics, etc. Yes _____ No _____

7. Should more emphasis be given to industrial engineering courses such as quality control, systems analysis, operations research, job evaluation, etc. Yes _____ No _____

8. Please jot down any additional comments or suggestions on a separate sheet of paper and enclose with this questionnaire.

9. Your job title _____

10. How long ago did you complete your college education? _____

11. Do you favor a portable pension plan for mining engineers? Yes _____ No _____

12. Please fill in this questionnaire and mail as soon as possible to Engineering & Mining Journal
330 West 42 St.
New York 36, N. Y.

Course Included in Current Mining Curricula

Mining
- Elements of mining
- Mining methods
- Mine surveying
- Mine plant design
- Mine design
- Ventilation
- Materials handling
- Rock mechanics
- Prospecting and developing
- Mine evaluation
- Mine rescue and safety
- Seminars
- Mineral economics
- Mine management
- Mining law

Mineral processing
- Ore dressing
- Fire assaying
- Metallurgy

Geology
- Mineralogy
- Petrology
- Physical geology
- Historical geology
- Structural geology
- Geology of ore deposits

Mathematics
- Basic through first year calculus
- Advanced, second year calculus

Chemistry

Physical chemistry

Engineering and physics
- Drawing
- Plane surveying
- Statics and dynamics
- Mechanics of materials
- Electrical engineering
- Fluid mechanics
- Thermodynamics
- Structural design

Humanities
- English
- Literature
- History
- Philosophy
- Art
- Music
- Psychology

Others

_____

_____

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THIS MONTH IN MINING

INCO Expanding Iron Ore Facility at Copper Cliff

INTERNATIONAL NICKEL COMPANY of Canada, Ltd. is under way with a $50-million expansion of its Copper Cliff, Ontario, iron ore recovery plant. The expansion is expected to triple the plant's present capacity.

Henry S. Wingate, Inco's board chairman, has said that a process developed by the company's research staff will permit extraction of 900,000 tons of 68%-iron pellets from 1,200,000 tons of nickeliferous pyrrhotite per year. According to Wingate, the process "involves solid state pyrometallurgical operations and the removal of nickel by atmospheric pressure leaching in units of novel design."

The expansion will cut the tonnage of material now handled by the Copper Cliff smelter's nickel section by 40%. At the same time, the new iron ore plant will recover more nickel from the same amount of pyrrhotite than is possible in the existing nickel smelter.

The new operation is scheduled to go onstream in 1963, and Wingate has stressed his belief that growing markets for high-grade iron ore will warrant full capacity operation.

Beryllium Resources, Dynamics Metals Merge

DYNAMIC METALS CORP. will be absorbed by Bruce W. Odlum's Beryllium Resources, Inc. in a merger voted by the boards of directors of both companies.

The parent company has been active in exploration for and development of beryllium sources, and Dynamic Metals has developed a new flotation process for the concentration of beryllium minerals.

All stock in the combination will be owned by Brush Beryllium Co., Federal Resources Corp., Hidden Splendor Mining Co., and Dr. Edward Van Dornick, vice president of Dynamic Metals, who was responsible for the development of the flotation process. Brush Beryllium will acquire 10-15% of the interest in the merged company, and it is expected that Brush, one of the major U.S. producers of BeO and beryllium metals, will become increasingly dependent on domestic ore sources. Beryllium Resources, Inc. owns beryllium ore claims in the Topaz Mountain area of western Utah and is presently engaged in a nation-wide search for beryllium ores.

◀———

Please tear off the opposite questionnaire after you have completed it, and mail to The Editor, Engineering & Mining Journal, 330 West 42nd St., New York 36, N.Y.

As We Went to Press . . .

U.S. AEC has disclosed that it has contracted to buy 190,674,000 lb of uranium oxide for $1,552,800,000 from 27 domestic mill operators through Dec. 31, 1966.

The Commission also has 12 contracts under review, most of which expire around March 31, 1962, but two of which go to Dec. 31, 1966. Some of the 12 may be extended to the December date. (See Washington Impact, p 24, and This Month in Mining, p 130.)

Molybdenum Corporation of America has announced discovery of an estimated 260-million ton molybdenum orebody in the Red River district of New Mexico, near Taos. The ore grades about 0.25 MoS_2.

Drilling on the property from mid-1957 to mid-1960 at the Questa site was done with DMEA assistance, and resulted in the ore estimates. The corporation is reported to have discovered higher grades in other drilling, and, in the period from 1923 to 1956, Moly Corp. had mined individual high grade deposits which ranged from 3% to 8%. The property ceased production in 1956 when the high grade became scarce.

A 50-ton mill is on the property, and, according to Marx Hirsch, president of the firm, can be expanded to handle 200 tpd. Hirsch said additional drilling and exploration must be carried on at the site before a decision on mining methods can be made.

Koppers Corp. is designing a steel mill for Webb & Knapp Strategic Corp., the firm which will use the Strategic-Udy process to extract approximately 350,000 tons of steel per year from the copper slag pile at Anaconda's Montana smelter. The cost of the plant is estimated at $30- to $40-million.

Construction is to begin by May 1961 on the plant, which will use the process tested at Strategic Udy's Niagara Falls, N.Y. plant, since proved commercial.

Success of the project is based on the already confirmed availability of 2-mill power near the site and upon sale of by-products, which will include copper, zinc oxide, cement and "slag-slag." The latter is to be sold as construction aggregate. The Montana Bureau of Mines has announced that suitable amounts of flux material are available in the area.

The Mississippi Industrial and Technological Research Commission announced last month that AEC had set Dec. 20 as the date for opening bids at Hattiesburg, Miss., for exploratory drilling preparatory to possible nuclear tests in salt domes some 30 miles southwest of the city.

A new sulphur mine has gone into operation on the Gulf of Mexico, about 60 miles southwest of New Orleans. Freeport Sulphur Co. opened the Lake Pelto deposit late last month, and will use the barge-mounted plant which was originally operated at the Bay St. Elaine property. Output of the property can not be estimated until the Frasch process has been applied to the salt dome, but Freeport spokesmen characterize the orebody as "less than a major deposit."

WASHINGTON IMPACT

Highlights

THE "INTER-REGNUM"—The hiatus between administrations in Washington is proving to be a painful one for several specific domestic industries, including some metal-mineral producers. Despite sincere efforts by both political party leaders to make the change as smoothly as possible, differences in approach to such problems as the U.S. balance of payments deficit, trade policies, foreign aid and domestic resources programs are creating uncertainties.

On the surface, President-elect Kennedy's foreign economic policies are not at real odds with outgoing President Eisenhower's. Both are internationalist, freer-trade and aid. And on domestic issues of particular concern to mining industries, both favor more research and development, some tax incentives. But on details, the incoming expert advisers differ sharply with present stands. Here are some of the main problems that have been spotlighted by the "inter-regnum," which will remain for the new Administration's action:

ALUMINUM AND IMPORT COMPETITION—The surprise inclusion of crude aluminum and alloys on the U.S. supplemental list of items on which the Government proposes to bargain reciprocal import concession under the General Agreement on Tariffs and Trade (GATT) at Geneva, Switzerland, next year, underscores the fence-straddling U.S. trade policymakers feel necessary on import policy regardless of which party controls the White House and Congress.

Officially, aluminum is being proposed for U.S. tariff cuts in response to a broader policy goal of expanding trade with Canada. U.S. negotiators hope to win Canadian concessions on domestic aluminum exports, too, including semi-fabricated and finished forms. Also, the Government was under some pressure from domestic aluminum processors who testified vigorously that they are in a cost-supply squeeze.

On the other hand, the decision—which will be debated at public hearings before the Tariff Commission and the inter-agency Committee for Reciprocity Information starting in January 1961—hit domestic producers hard. All three major producing companies, Aluminum Company of America, Kaiser Aluminum Co., and Reynolds Metals Co., have indicated they will oppose the move strongly.

As an example of the confused picture the proposal presents, Reynolds president Richard S. Reynolds, Jr., differs with Kennedy's over-all liberal import stand, and has proposed specific aluminum import quotas. Reynolds was a director of Kennedy's campaign business advisory committee.

TARIFF BARGAINING DELAYED—Equally upsetting to some Washington industry representatives is an admission by Administration trade officials that U.S. tariff negotiations scheduled to get under way at GATT sessions in January probably will be delayed until as late as March. This month, speculation is high on the question whether this move means that basic U.S. offers and demands of concessions will be changed.

Kennedy advisers say "no," that the new Administration will go along with the basic position tediously hammered over the past nine months under the present White House planners. But the Democrats also accuse the Administration of stalling the date of the negotiations to shift responsibility to the Kennedy regime.

To further muddy the outlook, reports are mushrooming that the Tariff Commission is setting so-called peril points so high on numerous commodities—including some minerals and chemicals—that U.S. negotiators at Geneva will not be able to offer substantial duty concessions they feel they need to win reciprocal benefits for U.S. exports.

THE AUGUSTA EDICTS—President Eisenhower's orders last month aimed at reducing the national outflow of gold and dollars are too broad to be easily translated in terms of direct effect on domestic business, including mining. Initial estimates are that the new "Buy-American" exhortations probably will not have much direct impact on the commodity markets, including purchases by the U.S. military as well as foreign aid programs. But there is an implication in the new approach—if followed up by President-elect Kennedy—that the Government will not encourage overseas investment by domestic producers as much as it has in the past.

AEC Releases Details Of Uranium Purchase Policy

AEC purchase contracts, under the official hold-down program of uranium buying announced two years ago, have been made public for the first time. They show in individual contract detail how and where the Atomic Energy Commission will spend the $1.5-billion earmarked for domestic purchases. The program has been criticized by domestic producers as inadequate.

The total U_3O_8 remaining to be bought is 190.7-million lb, 74.3-million lb scheduled for delivery before 1962, 116.4-million lb in the 1962-66 period. The AEC outlay is set at $1.55-billion, $931.5-million of which will be spent after 1962. The contracts total 27, including 12 calling for basic deliveries before 1962, 15 extended to cover the later period.

Prices during the pre-1962 period vary, AEC reports, and are tied to Bureau of Labor Statistics escalator clauses. But they do not on average go much above the pegged $8.00-lb rate. Post-1962 purchases are set at the $8.00 price "with a few minor exceptions."

The 12 pre-1962 contracts are with the following companies:

Homestake-New Mexico Partners, Kermac Nuclear Fuels Corp., Lakeview Mining Co., Mines Development Inc., Rare Metals Corp. of America, Susquehanna-Western Inc., Texas-Zinc Minerals Corp., Trace Elements Corp., Union Carbide Nuclear Co., Vanadium Corp. of America, Vitro Chemical Co.

The extended contracts are with:

Anaconda Co., Climax Uranium Co., Cotter Corp., Dawn Mining Co., Federal-Radorock-Gas Hills Partners, Globe Mining Co., Gunnison Mining Co., Homestake-Sapin Partners, Kerr-McGee Oil Industries Inc., Petrotomics Co., Phillips Petroleum Co., Susquehanna-Western, Uranium Reduction Co., Utah Construction and Mining Co., Western Nuclear Corp.

Prices in the first group vary between $10.76 and $7.46 per lb, in the second group from $9.90-$7.72.

New Administration Laws May Favor Mine Industry

NEW FACES and policies—President-elect Kennedy's deliberateness in signing up his new group of policymakers—from Cabinet to what is referred to in Washington as the "working level"—has dampened serious speculation about new policies in any area, including metal-mineral fields.

However, mining men in Washington share a general optimism that the new Administration will be at least as sympathetic to industry problems as the Eisenhower Administration, and they hope for even more results.

Here are some of the bases for the optimism:

Domestic mineral policy—A leading candidate for the key job of Assistant Secretary of Interior for metals and minerals mining is Robert Redwine, anchorman on retiring Sen. James Murray's (D-Mont.) Interior and Insular Affairs Committee staff. One of Redwine's prime objectives, if appointed, will be to draft new national minerals policy legislation.

Presumably, this would include provisions for expanded Government subsidies to domestic mines on grounds of their contribution to national security.

Specifically, in his present job, Redwine is preparing a staff report which will raise the issue of a need for domestic gold mining subsidies, and also a possible hike in the price of silver.

Legislative climate—more broadly, mining representatives are counting on a distinctly sympathetic ear on Capitol Hill to their problems. Sen. Clinton Anderson (D-N.M.) is the odds-on favorite to succeed Murray as chairman of the Senate Interior Committee. Second-guess is Sen. Alan Bible (D., Nev.). Both men are considered staunch friends of domestic mining industries, as is Rep. Wayne Aspinall (D., Colo.), who will retain chairmanship of the House Interior Committee. All three are on record in favor of more Government aid to domestic mining, including subsidies and increased stockpiling as well as stepped-up research and development aids, and opposed to freer-trade policies where foreign competition pinches U.S. sales.

Trade policy—no one anticipates any direct metal-mineral trade protection to be proposed next year. However, President-elect Kennedy has publicly come out in favor of so-called trade adjustment programs to help out domestic producers hurt by foreign competition.

Ghana Project Is Seen Crucial to Free World

THAT the Valco consortium (see feature p 100) has taken positive steps toward the realization of Ghana's industrial development is thought to reflect a measure of Free World concern lest such opportunities go to Communist countries by default. As Alcoa chairman Frank L. Magee has said, African nation's development ". . . in many cases might well have been postponed for some years were it not for the present political considerations of some urgency. Most of these countries are relatively underdeveloped and will turn to the Western world or to the East for aid wherever the prospects seem best."

Edgar F. Kaiser, chairman of Kaiser Aluminum, has emphasized his belief that President Kwame Nkrumah is primarily interested in achieving autonomy for Ghana, avoiding East-West allegiances.

According to the NEW YORK TIMES, ICA now appears to be favorably disposed to sell risk insurance to the consortium at the premium rate of 1½%

Labor This Month

MINE-MILL EYES KENNEDY: Though the International Union of Mine-Mill and Smelter Workers withheld its backing from the Kennedy-Johnson ticket, union officers are counting heavily on the incoming Kennedy administration to relieve nonferrous employment—and union membership—doldrums. By latest count, union rolls appear to have dropped under 40,000 members from a one-time high of 100,000. (The subscription lists to the paper—the Mine-Mill UNION—reveal 38,000 subscribers.) Mine-Mill's post-election claim: that many of its locals supported the winning Presidential ticket.

DEMOCRATIC JOBLESS CURES: When the Kennedy administration takes over next month, the unemployment count is expected to total a hefty 5.3-million. Kennedy strategists are prepared to throw a series of proposals at the new Congress to stem the tide—some new, some warmed over. Officials of Mine-Mill and other unions are backing the proposals which range from broad Federal work projects to legislation pin-pointed for specific depressed communities. Here are some examples: A $250,000 depressed areas bill to spark new industry and jobs in coal, textile, manufacturing and other communities hit by long-term recessions. This proposal was vetoed by Eisenhower as too costly.

A quick $1.25 Federal minimum wage bill, hiking the current $1 an hour rate and extending the law to cover retail and service trades. This failed in Congress.

An emergency Federal Loan program, making funds available to the states to pay unemployment compensation to the jobless. Eisenhower used this in 1958.

If necessary—a broader program requiring the states to pay jobless benefits at a Federal level set by new legislation.

THE BATTLE OF BUNKER HILL: Mine-Mill's longest and toughest strike—against the Bunker Hill Co. of Kellogg, Idaho—has turned into a fight for survival. Some seven months ago, 1900 workers at Bunker Hill walked out, joined later by 400 MMSW members at American Smelting and Refining Co. What was a contest over wages and other contract provisions, evolved into a hassle over school lunch programs which were discontinued when children of MMSW members could not pay the 25¢ daily fee. When state relief funds were brought in, a dissident union group —the Northwest Metal Workers Union—protested. It is attempting to take over Mine-Mill's bargaining unit. The United Steelworkers, also a rival union group, put up $5,000 for lunch program. The issue now—which union will represent the Bunker Hill workers—is in the hands of the National Labor Relations Board.

HOFFA'S NEVER-ENDING TROUBLES: Just as a point when Teamster President James R. Hoffa expected to shuck off his court-appointed monitors, the Senate's McClellan anti-racketeering committee revealed it's back in business. On its new witness list for hearings starting this month—James R. Hoffa. Sen. John McClellan says his group wants to probe "racketeer control" of New York City locals of the International Brotherhood of Teamsters. This time Hoffa—a sworn enemy of President-elect Kennedy—intends to invoke the Fifth Amendment in his Congressional appearances.

Hoffa, meanwhile, is seeking to end the court monitorship over his union—on the grounds that the system is legally unworkable. If the court agrees, Hoffa will call a new Teamster convention for election of officers —with himself at the head of the list.

AUTOMATION—A SUMMIT SUBJECT: How to further the advance of automation, and at the same time protect employment, will be the topic of the first top-level labor conference under President-elect Kennedy. The new Chief Executive is planning a White House conference of management, labor and professional experts to find the answer to advancing unemployment caused by the advance of electronics—particularly in such key industries as steel and related metal-working fields. However, the conference will cover the whole subject and not just a few industries.

MARKETS

Chuqui, N.J. Zinc Strikes Settled; Primary Aluminum Tariff Questioned

THE E&MJ METAL PRICE index dropped from 122.2% of the 1947-49 average in October to 120.2% in November. Domestic copper which was cut to 30c in October remained at that level throughout November, causing the monthly average to drop 1c to 29.6c f.o.b. Copper's heavy index weight and a 1⅜c decline in the price of tin accounted for the depression.

Copper prices settled down in November after a turbulent session in October. All U.S. sellers except dealers sold at 30c a lb delivered, but none set any records. London, which had moved off steadily following U.S. price cuts, stabilized at the beginning of the month at about £220 (27½c). Stability was partially credited to continuance of the strike at Anaconda's Chuquicamata mine in Chile.

The Chuqui walkout ended on November 14 after six weeks of idleness and numerous rumors of settlement. Company officials estimated loss of copper during the strike at about 35,000 to 40,000 tons. Workers settled for a 25% increase and various fringe benefits. Early opinion suggested that the Anaconda settlement would set the pattern for Kennecott's December negotiations with workers of its El Teniente mine (15,000 tpm) also in Chile. Late in November, however, it was indicated that a similar hoist at El Teniente might still leave the pay scale there behind Chuqui. The Kennecott contract ends Dec. 31, 1960. A strike seems likely.

London was expected to move off with announcement of the strike settlement. It did momentarily and then began to move slowly upward. The gain, widely termed a technical one, was brought about by scurrying shorts attempting to cover without benefit of the usual Chilean surplus. The LME prompt bid closed the month at £231 (28.875c). Observers looked for London prices to be steady in December at a slightly lower level. Despite depressed activity, the 30c U.S. price was expected to hold through 1960.

Sir Ronald Prain, RST chairman, in November called for international price stability for copper. He termed variations in LME prices "harmful and upsetting to the industry." He said there was need to consider selling at fixed prices, "which would not mean the elimination of the LME as a useful pricing medium in the market." While the amount of physical copper exchanged through the LME is relatively small, vast quantities of metal are sold at prices based on daily LME quotations.

U.S. deliveries of copper in October slumped 27,000 tons and stocks moved up nearly 30,000. Outside the U.S., deliveries fell a similar amount, but a sharp decline in refined output kept stocks at the September level. U.S. fabricator stocks were down, but deliveries, sales and orders for more copper were all at lower levels.

A number of newsworthy occurrences sparked the November aluminum market. A prime shocker was the appearance of primary metal on the GATT supplemental bargaining list. The currently depressed market may aid the U.S. domestic industry in its battle to get it off. Opinion varies as to the outcome. Inclusion is aimed at furthering trade with Canada, but the price squeeze voiced by independent fabricators at May hearings undoubtedly had something to do with the State Department decision. Primary producers argue that imports can increase costs and push up prices, since they come in at the expense of U.S. output and force shutdowns. They say that the U.S. is now in a position to supply all domestic requirements. A cut in the 1¼c tariff on primary aluminum figures to do more harm to "Little Four" products than the "Big Three," each of whom nearly every day breaks news of prime producing activity abroad.

Primary output in October was 167,015 tons, 79.7% of capacity down from 80.3%.

Alcan took action on its announcement of intention to cut back by shutting down two potlines at its Arvida, Quebec, works leaving ingot production at about 80% of capacity. Kaiser Aluminum closed the third of its nine potlines at Chalmette, La., during the month.

United Pacific Aluminum Corp. will have a two potline reduction plant near Longview, Wash., with an ingot output of about 45,000 tpy starting 1962.

Kaiser and Consolidated Zinc Co. (Australia) will establish a new aluminum complex in Australia and New Zealand (see p 100 for details).

N.J. Zinc Co. settled its strike at two smelters and five mines late in November. Output of 10-11,000 tpm has been lost since August 5. Bunker Hill (6,200 tpm), out since May, continues struck.

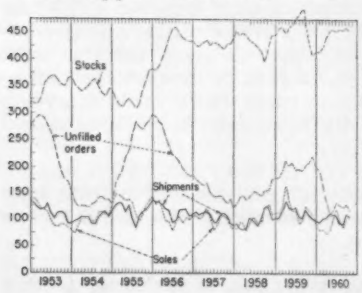
Industry stocks dropped only 2,000 tons in October. Officials, expecting a more substantial improvement, were disappointed. Sales reported to E&MJ in November were down 16% from the previous month.

The 13c East St. Louis price is decidedly more vulnerable now that one strike is out of the way, but some see it holding, owing to U.S. quotas, improved foreign markets and the thought a still lower price would probably not further activity.

Lead sales for November were about 40,000 tons, approximately 3,500 tons better than October. The 12c price is steady. Lead and zinc quotas will be maintained. The President has concurred with the recommendation of the Tariff Commission.

The N.Y. tin market was slow this month, showing a price decline of 1⅜c to 102c. London was slightly better than New York due to a more active European economy, and rose £2½ to £798½. However, both markets greatly show the effect of U.S. tin plater's unwillingness to restock inventories. How long present inventories will hold out is unknown and no one is even venturing a guess.

U.S. Copper Fabricator Data



Data in thousands of short tons from U.S. Copper Assn. The sales and shipment series are related only to purchases of refined copper by the fabricators, including copper refined by custom smelters from their intake of scrap and concentrates. All statistics refer to brass mills, wire mills and foundries. All series are for fabricated products except stocks which are of refined copper and copper in process. October is the last month indicated. Sales and shipments series are two months moving averages.

U.S. Aluminum

The left hand scale shows the percentage of capacity. "% cap." (heavy line) indicates the operating rate of U.S. primay plants; capacity is based on data released by aluminum firms and output on Aluminum Assn. figures. "Product ship" refers to U.S. Census data on shipments of aluminum mill products and of aluminum castings — products made from secondary and imported aluminum are included. "Sheet etc. ship" refers to Aluminum Assn. data on sheet, plate and foil. "To Gov't" refers to U.S. primary aluminum shipped to the U.S. Government. Annual figures for 1953-56 are estimated; 1957-59 are public. Monthly allocation of annual amounts is based on information (not specific tonnages) then current on changes in amounts taken by the Government. Data through September except "product ship" through August.

Average Prices November (E&MJ Quotations)

Cents per lb unless otherwise indicated:

Copper:	
Electro, domestic refinery	29.600
Electrolytic, exports refinery	27.470
Electrolytic, c.i.f. Cont'l ports	28.415
Lead:	
Common, New York	12.000
Common, St. Louis	11.800
Silver:	
Silver, New York, per oz	91.375
Silver, London, pence per oz	79.500d
Zinc:	
Prime, Western, East St. Louis	13.000
Prime, Western, delivered (g)	13.500
Tin:	
New York Straits	102.875
Gold, per oz, U.S. price	$35.000
Sterling, Exchange	281.352
Quicksilver, per flask	$209.000
Antimony, (E&MJ) (d)	32.590
Antimony, bulk, Laredo	29.000
Antimony, in cases, Laredo	29.500
Antimony for. 99%	23.875
Palladium, troy oz	$24.000
Platinum, refined, per oz	82.000
Cadmium (a)	150.000
Cadmium (b)	160.000
Al, 99½% unalloyed ingot	26.000
export, ingot	23.250
Magnesium, ingot	35.250
Nickel, (f)	74.000
Bismuth	$2.250
Cobalt	$1.500

Domestic quotations, unless otherwise stated are in cents per lb. Sterling exchange checks, in cents. Quicksilver per flask of 76 lb.
(a) Per lb delivered, ton lots.
(b) Per lb delivered, small lots.
(d) Domestic 5 tons or more but less than carload lots, packed in case f.o.b. New York.
(f) Contract price, f.o.b. Port Colborne U.S. duty included.
(g) Delivered where freight exceeds 0.5c.
(h) 2c duty extra.

Free Gold Market

International gold trading volume declined 10½% during November, following the October "Gold Rush." Bar prices were fractionally lower, while coins remained strong. Since mid-October, about $250 million of the yellow metal sold in world markets went into private or corporate hoards. Gold futures continued active. European dealings averaged $2½ to $3 million daily; Canadian transaction increased carrying charges, based on the $36 level for spot gold, listed at 4% p.a. in Zurich and 4¾ to 5% p.a. in London. The U.S. gold stock maintained its steady decline, reaching a new low of $17.986 billion. Pick's World Currency Report quotes on "free gold" per fine oz. as follows:

	Coins		Bars (12.5 kg)	
	Oct. 31	Nov. 30	Oct. 31	Nov. 30
New York transit	.....	.....	$36.00	$35.75
Manila	$41.50	$41.60	37.50	37.00
Hong Kong	48.50	48.85	40.65	41.12½
Bombay	54.30	54.00	51.25	51.00
Beirut	41.00	41.05	36.28	35.90
Paris	40.60	41.35	36.90	36.15
Buenos Aires	41.80	41.60	37.80	37.40

Note: Prices are quoted at the free or black market value of the U. S. dollar in the local markets.

Custom Smelter Copper

Based on flat price and E&MJ average price sales in U.S. for month of November reported by American Smelting & Refining Co. electrolytic copper in standard shapes, adjusted to nearest ⅛c; ¼c deducted for selling common.

Delivered consumer's plant .29.750 lb
F. o. b. refinery .....29.350 lb

Major Metals

U.S. DAILY AND AVERAGE PRICES

Cents per lb unless otherwise indicated:

Nov. 1960	Electrolytic Copper (a) Domestic	(b) Export	Europe c.i.f. (e)	Lead New York	Lead St. Louis	Zinc (f) Delivered	Zinc East St. Louis	Aluminum Ingot 99% U. S. Dest.	Straits Tin New York
1	29.600	26.825	27.770	12.000	11.800	13.500	13.000	26.000	103.375
2	29.600	26.825	27.770	12.000	11.800	13.500	13.000	26.000	103.250
3	29.600	26.700	27.645	12.000	11.800	13.500	13.000	26.000	103.375
4	29.600	26.800	27.745	12.000	11.800	13.500	13.000	26.000	103.375
7	29.600	26.825	27.770	12.000	11.800	13.500	13.000	26.000	103.250
8	Holiday	27.075	28.020	—	—	Holiday	—	—	—
9	29.600	27.575	28.520	12.000	11.800	13.500	13.000	26.000	103.250
10	29.600	27.625	28.570	12.000	11.800	13.500	13.000	26.000	103.250
11	Holiday	27.725	28.670	—	—	Holiday	—	—	—
14	29.600	27.475	28.420	12.000	11.800	13.500	13.000	26.000	103.000
15	29.600	27.450	28.395	12.000	11.800	13.500	13.000	26.000	102.875
16	29.600	27.625	28.570	12.000	11.800	13.500	13.000	26.000	102.625
17	29.600	27.550	28.495	12.000	11.800	13.500	13.000	26.000	102.625
18	29.600	27.550	28.495	12.000	11.800	13.500	13.000	26.000	103.125
21	29.600	27.550	28.495	12.000	11.800	13.500	13.000	26.000	102.875
22	29.600	27.675	28.620	12.000	11.800	13.500	13.000	26.000	102.750
23	29.600	27.900	28.845	12.000	11.800	13.500	13.000	26.000	102.750
24	Holiday	27.650	28.595	—	—	Holiday	—	—	—
25	29.600	27.875	28.820	12.000	11.800	13.500	13.000	26.000	102.625
28	29.600	27.800	28.745	12.000	11.800	13.500	13.000	26.000	102.250
29	29.600	28.075	29.020	12.000	11.800	13.500	13.000	26.000	102.000
30	29.600	28.200	29.145	12.000	11.800	13.500	13.000	26.000	102.000
AVERAGES FOR MONTH									
Nov.	29.600	27.470	28.415	12.000	11.800	13.500	13.000	26.000	102.875
AVERAGES FOR WEEK									
Nov.									
2	29.600	26.765	27.710	12.000	11.800	13.500	13.000	26.000	103.325
9	29.600	26.995	27.940	12.000	11.800	13.500	13.000	26.000	103.313
16	29.600	27.580	28.525	12.000	11.800	13.500	13.000	26.000	102.938
23	29.600	27.645	28.590	12.000	11.800	13.500	13.000	26.000	102.825
30	29.600	27.920	28.865	12.000	11.800	13.500	13.000	26.000	102.219
CALENDAR WEEK AVERAGES									
Nov.									
4	29.600	26.755	27.700	12.000	11.800	13.500	13.000	26.000	103.375
11	29.600	27.365	28.310	12.000	11.800	13.500	13.000	26.000	103.250
18	29.600	27.530	28.475	12.000	11.800	13.500	13.000	26.000	102.850
25	29.600	27.730	28.675	12.000	11.800	13.500	13.000	26.000	102.750

THE above quotations for major nonferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis. All prices, except gold and silver, are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered U.S. basis add 0.400c per pound, the average differential for delivery charges.

(b) Export copper daily quotations are weighted averages based on sales outside the U.S. reported to E&MJ. Ocean freight and 0.125c lighterage and handling are deducted to arrive at the f.o.b. Atlantic seaboard refinery quotation. On f.a.s. U.S. sales lighterage of 0.125c is deducted.

(e) The c.i.f. Continental ports quotation is arrived at by adding to the f.o.b. export quotation lighterage, and the standard conference freight and insurance, Atlantic ports to main Continental ports. Currently this is 0.125c and 0.82c.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingots; cathodes are sold at a discount of 0.125c to 0.15c per pound. Quotations for zinc are based on Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East, Middle West and West effective Apr. 1, 1960, commanded a premium of 1.50c per pound over the current market for Prime Western; Special High Grade 1.75c effective Apr. 1, 1960.

(f) Prime Western delivered where freight from E. St. Louis exceeds 0.500c.

Quotations for lead are based on domestic common lead. Corroding lead commands a premium of 10 points (almost all U. S. lead is corroding grade).

(c) The daily silver quotations reported by Handy & Harman, in cents and fractions of a cent per troy ounce, is the price paid by Handy & Harmon in settlement for silver contained in unrefined silver-bearing materials submitted to them for refining. It is determined on the basis of offers of bar silver .999 fine as made to Handy & Harman for nearby delivery at New York by regular suppliers in quantities sufficient to meet daily requirements, and it is usually 0.250c below the price at which such offers are made.

The Treasury's purchase price of newly mined domestic silver is 90.5c per troy ounce 1000 fine effective July 1, 1946. London silver in pence per troy ounce, basis .999 fine.

(d) U. S. Treasury's gold price is $35. Actual payment by the United States Treasury for gold is at 99.75 per cent of the price quoted by the Treasury, which is equal to $34.9125.

Silver, Gold and Sterling

DAILY AND AVERAGE PRICES

Oct. 1960	Silver (c) New York	Silver London	Sterling Exchange	Gold (d) London
1	91.375	79.500d.	281.6000	256s. 0d.
2	91.375	79.500d.	281.6825	256s. 0d.
3	91.375	79.500d.	281.6820	258s. 0d.
4	91.375	79.500d.	281.5100	256s. 9d.
7	91.375	79.500d.	281.4760	255s. 0d.
8	Holiday	79.500d.	Holiday	256s. 6d.
9	91.375	79.500d.	281.6720	256s. 6d.
10	91.375	79.500d.	281.5780	255s. 6d.
11	Holiday	79.500d.	Holiday	254s. 6d.
14	91.375	79.500d.	281.2775	254s. 0d.
15	91.375	79.500d.	281.2280	253s. 3d.
16	91.375	79.500d.	281.3620	253s. 6d.
17	91.375	79.500d.	281.3140	253s. 6d.
18	91.375	79.500d.	281.2920	253s. 3d.
21	91.375	79.500d.	281.3080	253s. 0d.
22	91.375	79.500d.	281.2580	253s. 3d.
23	91.375	79.500d.	281.2680	253s. 5d.
24	Holiday	79.500d.	Holiday	254s. 6d.
25	91.375	79.500d.	281.2260	253s. 4d.
28	91.375	79.500d.	280.9800	253s. 6d.
29	91.375	79.500d.	280.9260	253s. 10d.
30	91.375	79.500d.	281.0460	253s. 6d.
AVERAGES FOR MONTH				
Nov.	91.375	79.500d.	281.352	—
AVERAGES FOR WEEK				
Nov.				
2	91.375	—	281.505	—
9	91.375	—	281.585	—
16	91.375	—	281.361	—
23	91.375	—	281.288	—
30	91.375	—	—	—

Calendar Week Averages: New York Silver: Nov. 4, 91.375; Nov. 11, 91.375; Nov. 18, 91.375; Nov. 25, 91.375.

MARKETS (*Continued*)

London Metal Exchange Quotations

Nov. 1960	Copper Cash Bid	Copper Cash Asked	Copper 3 Mon. Bid	Copper 3 Mon. Asked	Lead Current Month Bid	Lead Current Month Asked	Lead 3 Mon. Bid	Lead 3 Mon. Asked	Zinc Current Month Bid	Zinc Current Month Asked	Zinc 3 Mon. Bid	Zinc 3 Mon. Asked	Tin Cash Bid	Tin Cash Asked	Tin 3 Mon. Bid	Tin 3 Mon. Asked
1	220¼	220½	222	222¼	68⅛	68½	69¼	69⅜	88	88¼	86½	86¼	796	796½	795½	796
2	220	220¼	221½	221¾	68½	68⅝	69¼	69⅜	88¼	88⅜	86⅜	86½	797	798	796½	797
3	221½	221¾	223	223¼	68⅞	69	69½	69⅝	89	89¼	87	87½	802	802½	799	800
4	222¼	222½	223¼	223½	69⅛	69¼	69⅝	69⅞	88¾	88⅞	86¾	86⅞	803	803½	800½	801
7	224	224¼	224¼	224½	68½	68⅝	69	69⅛	88½	88⅝	86½	86⅝	803	803½	800	800½
8	224¾	225	224¾	225	69	69⅛	69½	69⅝	88¼	88½	86⅛	87	799½	800	797½	798
9	227¼	227½	227	227¼	69¾	69⅞	70⅛	70¼	89	89¼	87¾	88	802	802½	799	800
10	227½	227¾	227½	227¾	69½	69¾	69¾	70	88½	89	87½	87¾	799½	800½	797½	798
11	226¾	227	226¼	226½	68¼	68⅜	68⅝	69	87¾	88	86⅛	87	799	800	797	797½
14	224¼	224½	223¾	224	67⅝	67½	68¼	68⅜	86¼	86½	86¼	86⅜	799	799½	796	797
15	225½	225¾	225	225¼	67⅝	68	68⅝	69	86⅜	86½	86⅛	87	802	803	798	799
16	226¼	226½	225¾	226	68⅛	68¼	68¾	68⅞	87¼	87½	87½	87¾	803	804	799	799½
17	225½	225¾	224½	225	67⅞	68	68¾	68⅞	86¼	86½	86½	86¾	802	802½	798	799
18	226	226¼	225¼	225½	68½	68⅝	69	69⅛	86⅜	86¾	86⅛	87	801	802	797	797½
21	227¼	227½	225¾	226	68⅜	68½	68⅞	69	87¼	87⅜	87¼	87⅜	800	800½	797½	798
22	229½	229¾	227¾	228¼	67⅝	67¾	68¼	68½	88	88¼	87½	87⅝	799	800	796½	797
23	229¾	230	227¾	228	67⅝	67⅞	68½	68⅝	87¾	88	87⅝	87½	801½	802	797½	798
24	228½	228¾	226½	226¾	67⅝	67¾	68⅜	68½	87¼	87½	86¾	87	801	801½	798	798½
25	228½	228¾	226	226½	67¼	67⅝	68⅛	68¼	86½	86¾	86¼	86⅝	800½	801	798	798½
28	229¾	230	227¼	227½	66⅞	67	67⅝	67⅞	86⅞	87	86¼	86⅝	799	799½	796½	797
29	231	231¼	228¼	228½	66¾	66⅞	67⅝	67¾	86⅞	87	86½	86¼	798½	799	796	797
30	231	231¼	227¾	228	66¾	67	67¾	67⅞	86¾	87	86	86½	798½	799½	797½	798
Av'g's	£226.347		£225.631		£68.176		£68.875		£87.636		£86.864		£800.614		£797.955	

Prices are for the official a.m. session in pounds sterling per ton of 2240 lb. Copper basis wire bars, lead 99.0%, zinc 98% and tin min. 99.75%.

Miscellaneous Metals, Ores, Minerals

Quotations cover wholesale lots, prompt shipments, f.o.b. New York unless otherwise stated, tons of 2,000 lb unless otherwise noted. st—short ton; lt—long ton; stu—short ton unit; ltu—long ton unit. (p) duty extra.

MISCELLANEOUS METALS

Nov. 30, 1960

Aluminum ingot, 99.9% lb		28c
Antimony, spot, lb, less than carload, in cases		32.59c
In bulk, carload lots, f.o.b. Laredo		29.00c
Imported, 10 ton min. (p), 99% Duty not paid	23¾ —	24c
Bismuth, ton lots, lb		$2.25
Cadmium, ton lots delivered, lb		$1.50
small lots		$1.60
Calcium, lb, ton lots, 98%, cast		$2.05
Chromium, 99.8% grade, lb, contract delivered	$1.15 —	$1.19
Cobalt, 97 to 99%, per lb effective 3-1-60		$1.50
Germanium, per gram, 10,000 gram lots	(d)28.15c—(c)(d)29.95c	
Indium, troy oz	$1.35 —	$2.25
Lithium, lb, 98%	$9.00 —	$11.00
Nickel, cathodes, lb (a)		74c
Other sales, regular sellers		74c
Sales by dealers, etc		74c
Magnesium, 99.8% carloads, lb producer's plants, Velasco, Texas, effective Apr. 16		35¼
Palladium, troy oz	$24 —	$26
Platinum, troy oz	$81 —	$85
Quicksilver, flask of 76 lb, 25 flasks or more	$209 —	$212
Selenium, 99 plus %, lb—(Feb. 19, 1958)	$6.50 —	$7
Silicon, minimum 98%, carloads, lb		19c
Semi Conductor grade, lb		$360
Tellurium, lb		$4.00
Thallium, 100 lb or more		$7.50
Titanium, 99.3% plus, grade A-1, max. 3% Fe, lb (b)	$1.50 —	$1.60

(a) Effective Dec. 6, 1956; including U. S. duty; (b) Effective Aug. 1, 1959. (c) Delivered; (d) f.o.b. plant.

METALLIC ORES

Beryllium ore, imported, 10% BeO, (b) stu; spot	$31.75 —	$32.50
term contracts	$34 —	$34.50
Chrome ore per long ton, f.o.b. cars Atlantic ports, dry:		
44% Cr_2O_3 no ratio	(a)$19.75 —	$20.50
48% Cr_2O_3 3 to 1 ratio	$35¾ —	$38
Iron ore, Lake Superior, Lower Lake ports, lt		
Old Range bessemer		$11.70(e)
Mesabi bessemer		$11.60(e)
Mesabi non bessemer		$11.45(e)
Lead (Galena), 80%, Joplin, Mo., ton		$141.72
Manganese ore—per ltu of Mn basis 48%, nearby positions, subject to premiums and penalties, c.i.f. U. S. ports import duty extra., (n)87c—90c. Long-term contract nominal.		
Molybdenum ore, 90%, per lb of Mo f.o.b. mines		$1.25
Columbium-Tantalum, per lb, combined oxides 10 to 1 ratio	$1.18 —	$1.25
Tungsten ore, per stu of WO_3:		
Foreign 60%, c.i.f. U. S. ports, duty extra	$18.50 —	$19.00
U. S. scheelite, f.o.b. mill	$22 —	$24
Vanadium ore, per lb of contained V_2O_5 f.o.b. mines		31c
Zinc ore, Prime, 60% concentrate, Joplin, Mo., per ton		$80

(a) Nominal. (b) c.i.f. U. S. ports. (e) Effective 1958 shipping season.

METALLIC COMPOUNDS

Arsenous oxide (arsenic trioxide) lb, in bbl, carload lots N. Y. docks		4–5c
Cobalt oxide, 72½% to 73½%, per lb, effective Mar. 1, 1960	$1.15 —	$1.18
Copper sulphate, 100 lb. effective 10-12-60		$12.25
Germanium dioxide, gm		16¾c
Molybdic trioxide, technical, per lb of Mo	$1.46 —	$1.47
Imported, including 37c duty	$1.75 —	$2.05

ALLOYS

Ferrochrome 65 to 70%, per lb of Cr, (4-9% C)		28¾c
Ferromanganese, 74 to 76%, per lb shipping point		11c
Ferromolybdenum, 58 to 64% Mo. lb of Mo contained	$1.50 —	$1.82
Ferrosilicon, 50% per lb of Si f.o.b. shipping point (3-1957)		14.60c
Ferrotungsten, 72 to 82%, lb of W contained		$2.15
Ferrovanadium, per lb of V delivered	$3.20 —	$3.40
Silicomanganese, max., 1½% C, lb contracts		11.6c
Spiegeleisen, per lt, 19–21% grade effective Jan 22	$100.00 —	$102.50

NONMETALLIC MINERALS

Asbestos, f.o.b. Canada (Quebec) mines (Canadian funds) ton:

Crude No. 1	$1,400–$1,725	Paper stock	$120–$142
Crude No. 2	$750–$1,100	Waste	$75– $86
Spinning Fibers	$370– $600	Shorts	$40– $75
Shingle fibers	$180– $220		

Asbestos, f.o.b., Vancouver, B. C. (Canadian funds):

Crude No. 1	$1,522	Spinning fibers	$220–$787

Asbestos, Vermont, f.o.b. Morrisville:

Spinning fibers	$353– $408	Waste, stucco or plaster	$86
Shingle stock	$181– $218		
Paper stock	$120– $142	Refuse or shorts	$41– $75

Barytes, f.o.b. cars:		
Georgia, crude, per ton		$18
Missouri, 94%, $BaSO_4$, per st	$16 —	$18
Crude oil well grade, min. 4.3 sp gr, st (a)		$18
Imported, c.i.f. Gulf Ports, st	$16 —	$18
Bauxite, st, f.o.b. point of shipment:		
Imported metallurgical, per lt, f.o.b. Br. Guiana, 60% Al_2O_3, 6% SiO_2, 1.25% Fe, 1-1-60		$7.25
Feldspar, bulk ton; f.o.b. plants:		
Potash or soda feldspar, 200 mesh, ceramic grade	$17 —	$20.50
Glass feldspar, white, 20 mesh		$9
Fluorspar, f.o.b. mines, bulk, 72½% effective, ton	$37 —	$41
60% effective CaF_2	$33 —	$36
Acid 97% concentrate, bulk, ton		$45.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00 —	$14.00
Magnesite, per ton dead-burned, bulk, f.o.b. Washington		$46

Mica—Domestic, f.o.b. mines, Punch 7c-12c per lb according to size and quality. Sheet clear 1½x2 in. 70c-$1.10; 2x2 in $1.10 to $1.60; 2x3 in, $1.60-$2.10; 3x3 in, $1.80-$2.30; 3x4 in, $2.00-$2.60; 3x5 in, $2.60-$3.00; 4x6 in, $2.75-$4.00; 6x8 in, $4.00-$8.00. Wet ground, very fine, $140-$155 per ton. Bulk sales, dry ground; $30-$55 per ton. Scrap $20-$30.

Ocher, Georgia, ton in sacks	$26.50 —	$32.00
Sulphur, Mexican, for use in Mexico, metric ton, f.o.b. mines, depending on location	$21 —	$23
For export f.o.b. vessel, depending on grade	$20.50 —	$22

Actual prices received by U. S. producers approximate the Mexican export prices.

Talc, f.o.b. works, ton:		
New York, purified	$18.00 —	$20.00
Vermont, extra fine		$12.50
Tripoli, Missouri, ton:		
40-mesh, cream colored		$50.00

(a) Some restricted sales at $11.50, (b) Corrected. (c) Nominal.

IRON AND STEEL

Pig iron, gross ton, basic, Valley furnaces		$66.00
Steel, f.o.b. Pittsburgh, billets, net ton		$80.00
Structural shapes, Pa., Ala., etc., 100 lb	$5.30 —	$5.50

How the clam-action 4-in-1 gives you

'equipment spread' utility...

with a one-man "crew"!

Move the "machine action" selector lever—see for yourself how the International Drott 4-in-1 gives you equipment spread utility with a one-man "crew"—does dozens of jobs, other excavator-loaders can't touch! Prove that the 4-in-1 saves you the expense of buying or renting additional machines, and of hiring extra operators. Let your International Drott Distributor demonstrate!

International Harvester Co., Chicago 1, Illinois

Drott Manufacturing Corp. Milwaukee 15, Wisconsin

INTERNATIONAL DROTT

You get a full-capacity, earth rolling bulldozer simply by opening the 4-in-1's clam—with 2-finger hydraulic lever ease. This TD-15 Four-in-One is clearing off brush and removing overburden from a deposit of sub-base materials.

Let the 4-in-1 double for a boom-type shovel in many conditions—as this operator does. Here, his 1⅛ cy. yd. TD-6 Four-in-One applies famous pry-over-shoe break-out action and "doubles for dynamite" to dig hard materials without shooting.

End sticky materials problems for good, the way dredging contractors do: with positive clam-action bottom-dumping. Note how opening the 4-in-1's clam pulls materials from bucket surfaces—and gravity down-pull does the rest—to enforce positive, self-cleanout dumping.

You can back-drag materials wholesale (and safely) from the sand, clay, or gravel bank. And use this same action to grab, carry, and load heavy, unwieldy "impossibles" including stumps, boulders, and slabs of rock—without delay or extra help!

Install headed roof bolts in four simple steps

1 **DRILL THE HOLE** to required depth and diameter with rock drill. Maximum strength is obtained when the hole is drilled perpendicular to the roof surface.

2 **INSERT THE BOLT,** preassembled plate and hardened washer, and expansion shell in the hole. For special conditions two or more bolts may be connected with a steel roof tie which is installed under the plate washers.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. Export Sales: Bethlehem Steel Export Corporation

Bethlehem roof bolts are designed to minimize the probability of troublesome and often dangerous roof falls.

Bethlehem also makes slotted bolts. These are installed so that a steel wedge spreads the split bolt ends, causing them to grip the rock tightly and securely.

For all the details on Bethlehem roof bolts call your nearest Bethlehem sales office. You might also like to see a copy of our 20-page, illustrated catalog on roof bolting. Write us at Bethlehem, Pa., for your copy.

Steel

for Strength
. . . Economy
. . . Versatility

3 **TIGHTEN THE ASSEMBLY** with an impact wrench to complete the installation. When tightened in the hole the leaves of Bethlehem's Type "C" expansion shell expand in four directions to lock the bolt securely in place.

4 **TEST THE INSTALLATION** to assure the accuracy of equipment and bolting crews. Tension testing may be performed at regular intervals. Bethlehem engineers are available to work with your crews on any aspect of the job.

BETHLEHEM STEEL

BETHLEHEM STEEL

Economy never came in such a choice!

NEW FORD TRUCKS

FOR 1961

619 NEW MODELS! All engineered with one idea in mind... economy! New "Big Six" engine for 2-tonners plus five Cummins diesels for the new H-Series tractors expand the proven line of Ford engines to 18—with one just right for your job. A wider-than-ever choice of transmissions and axles. And . . . on all 1961 Ford Trucks, each part, except tires and tubes, is now warranted by your dealer against defects in material and workmanship for 12 months or 12,000 miles, whichever occurs first. The warranty does not apply, of course, to normal maintenance service or to the replacement in normal maintenance of parts such as filters, spark plugs and ignition points.

FORD TRUCKS COST LESS

YOUR FORD DEALER'S "CERTIFIED ECONOMY BOOK" PROVES IT FOR SURE!

New! Durable Tandems

Ford's Tandem Axle trucks for '61 are engineered to give you greater flexibility and significant payload advancements. Your choice of 22,000-lb., 28,000-lb., 30,000-lb., 34,000-lb., or 38,000-lb. axle capacity. New, longer wheelbases are available to permit installation of special bodies up to 21 feet long. Aluminum walking beams as well as aluminum wheels and gas tanks are optional for reduced chassis weights.

FORD DIVISION, Ford Motor Company.

New! "Big Six" Engine

More power for America's savingest 2-ton trucks . . . a big 262-cu. in. Six with the performance of big displacement, the durability of heavy-duty construction, plus the gas economy of 6-cylinder design! Available early 1961. You also get improved riding comfort with new smoother-acting springs and a sturdy truck suspension system that can give up to twice the front tire life of some other makes.

New! H-Series Diesel- or Gas-Powered Tractors

Ford's new H-Series tractors with 28-inch front axle setting and 82-inch BBC are offered in four single-axle and four tandem-axle models with over 500 engine-axle-transmission combinations. Choose from ten industry-accepted engines—five Cummins diesels and five Ford Super Duty V-8's!

New 100,000-mile warranty on Super Duty V-8 gas engines is most liberal in the industry. On 401-, 477- and 534-cu. in. V-8's, Ford Dealers will replace any major engine part (including block, heads, crankshaft, bearings, valves, pistons, rings) found to be defective in materials and workmanship in normal on-highway use. Warranty covers full cost of replacement parts for 100,000 miles or 24 months, whichever occurs first . . . full labor costs for first year or 50,000 miles, sliding percentage scale thereafter.

HEAVY TRUCK GENUINE PARTS Ford SERVICE DIESEL CUMMINS

NATIONWIDE SERVICE . . . *look for this sign at Ford Dealers' across the country, for service on all Ford gas and diesel trucks!*

New! Extra Heavies

Double-channel truck frames and single-channel frames of high-tensile steel for tractor models give proper strength with minimum weight. Wider power train choice, 28-inch front axle setting plus new high-durability cabs and sheet metal mean greater earning power for you.

New! 4-Wheel Drive Pickups

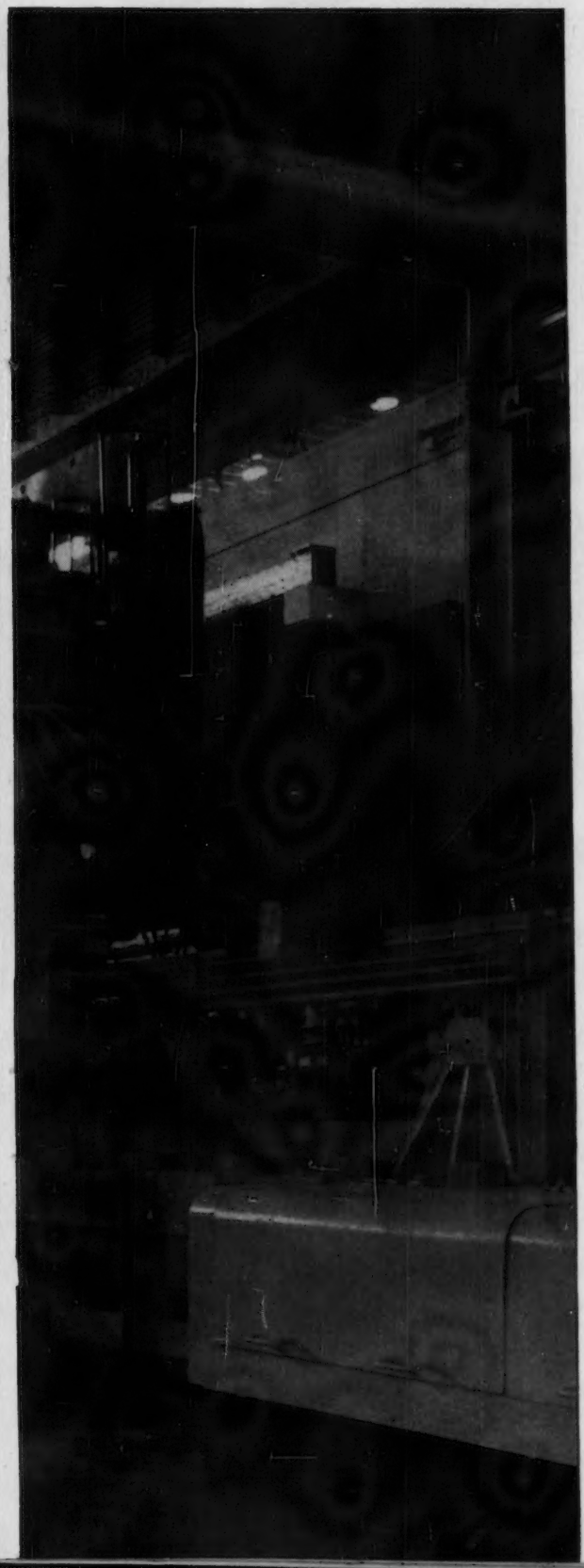
Ford offers the lowest-priced* 4 x 4 with big 8-ft. box. And these models have the traction to go most anywhere . . . road or no road! You can choose either the gas-saving 135-hp Six or the 160-hp V-8 that gives extra power with "six-like" economy.

**Based on a comparison of latest manufacturers' suggested retail delivered prices*

At Kennecott's new refinery... Twin Heroult Electric Furnaces designed

Copper cathodes are charged intc the 13,500 KVA Heroult 90-ton electric arc furnace, one of two at Kennecott Refining's new plant south of Baltimore. American Bridge also fabricated and erected the plant's structural framework.

to keep 16,500-ton per month copper melt on schedule



Kennecott Refining Corporation's electrolytic copper refinery near Baltimore is the country's newest—a showplace of efficiency. One reason: a pair of 90-ton Heroult electric arc furnaces, each rated at 40 tons per hour.

Of nose-tilt design to facilitate launder pouring, they discharge a steady stream of molten copper (2150°) which is used in the horizontal casting of wire bars and the continuous casting of billets. One Heroult is on normal capacity operation while the other is a spare for use during relining, when the pre-heat furnace is down, or when additional production is required.

Copper cathodes are preheated to about 1400°F and door charged into the Heroult arc furnace on a peel arm crane. The three-phase power input utilizing ultra-high speed mechanical positioning for three 20″ electrodes with high-speed sensitive regulators maintains a constant arc above the copper bath for uniform temperature casting.

The two 90-ton Heroult arc furnaces can be tilted 40° forward and 15° backward. They feature mechanically positioned masts and special water-cooled skew-back roof rings that introduce water flow at the critical roof juncture to prevent warpage and burn out.

Whatever your arc-melt problem there is a Heroult electric arc furnace design for you. We've made them from 3 tons to over 200 tons capacity, for both swing roof top charge or door charge operation. They can accommodate induction stirring equipment, and can be designed for duplexing arrangements. And every Heroult is designed for maintenance by your own crew.

American Bridge has a complete electric furnace service that includes new installation, furnace modernization and part replacement. We'll be happy to quote on your building needs, too. Call our nearest office.

USS and Heroult are registered trademarks

American Bridge
Division of
United States Steel

USS

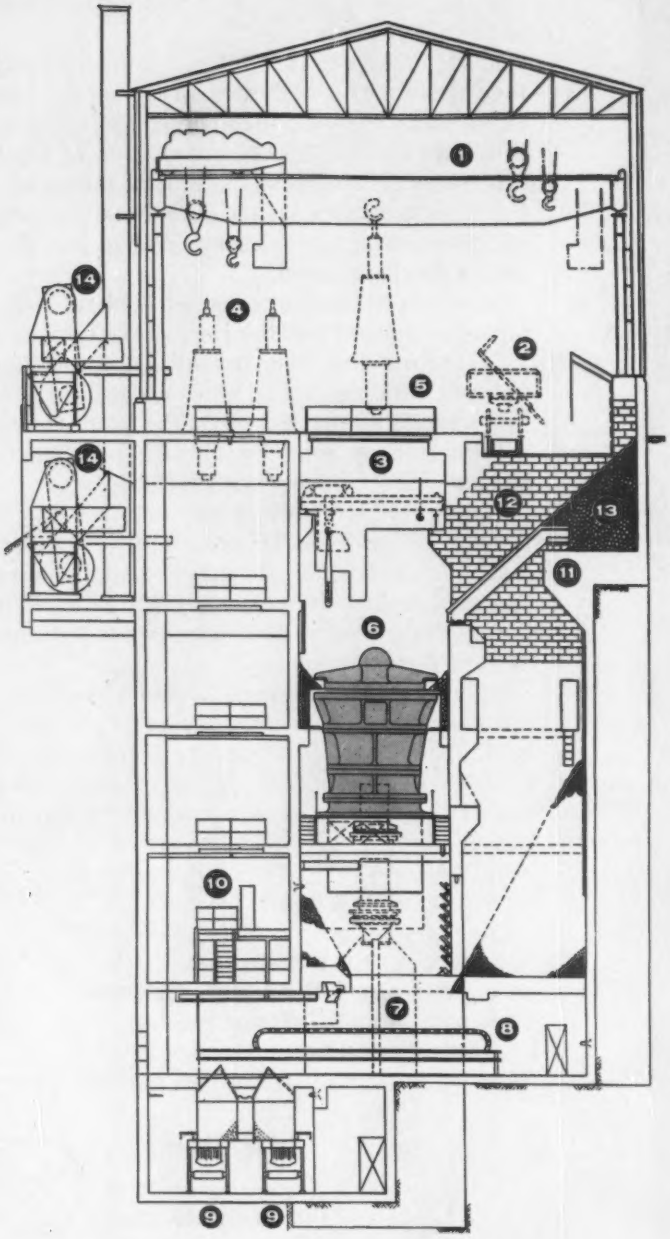
General Offices: 525 William Penn Place, Pittsburgh, Pa. Contracting Offices in New York, Philadelphia, Chicago, San Francisco, and other principal cities.
United States Steel Export Company, New York

This mark tells you a product is made of modern, dependable Steel.

Steel

1,000,000

POUNDS OF TRAYLOR ENGINEERING!



TRAYLOR

world's largest manufacturer of 60″ gyratory crushers designed and built this giant for installation in Peru.

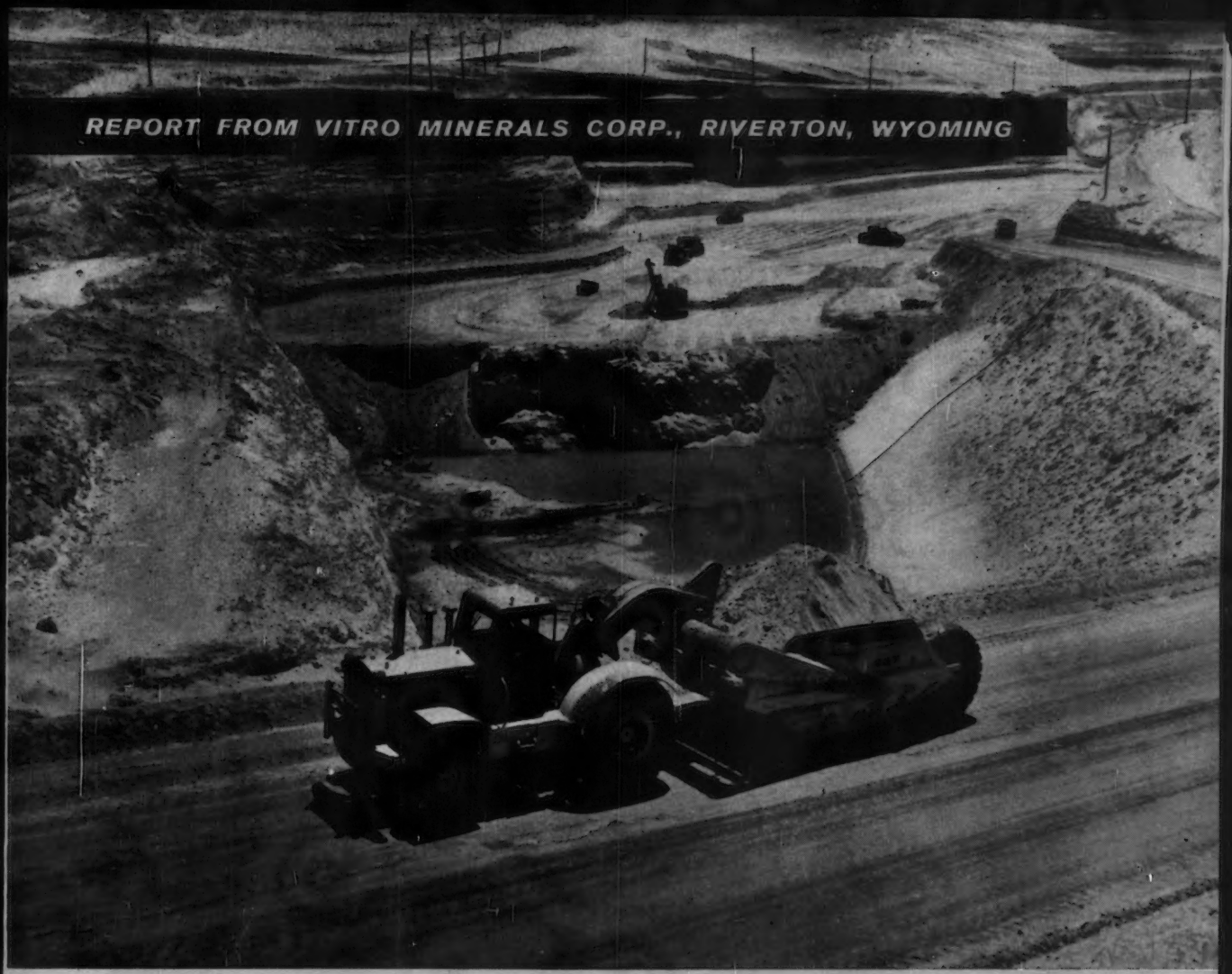
The Southern Peru Copper Corporation called on Traylor-made ECONOMY, EFFICIENCY, AND CAPACITY to handle the tremendous crushing workload at its new plant in Toquepala, Peru.

Drawing shows Traylor 60″ gyratory crusher operation:

1. 100-ton crane with 25-ton auxiliary hook and operator's cab
2. 43-cu. yd. side-dump mine car
3. 20-ton crane with rock hook
4. Mantle storage
5. 18 x 22-ft. removable hatch
6. 60-in. Traylor gyratory primary crusher
7. Hydraulic hoist, 14-ft. lift, 25-ton capacity
8. Two 72-in. pan feeders
9. Two 54-in. chain-belt conveyors
10. Electrical control panel
11. 8-in. grizzly
12. 2-in. plate liners
13. Dead-bed areas
14. Air filter dust removal unit

Other Traylor Crushers made for primary, secondary or fine reductions. Write today outlining your crushing requirements and let Traylor's engineers make recommendations . . . or ask for Bulletin No. 1126.

TRAYLOR ENGINEERING & MANUFACTURING
DIVISION OF FULLER COMPANY
1553 MILL STREET, ALLENTOWN, PA.



ADVERSE GRADE OUT OF PIT IS 6 TO 10%

—but DW20G averages 4-minute cycles on 1-mile round-trip haul!

This Cat DW20G-456B rig is one of four used by the Vitro Minerals Corp. to strip overburden from uranium ore near Riverton, Wyoming. Notice the adverse grade of 6 to 10% out of the pit. Even under such unfavorable conditions, this unit makes a mile round trip in 4-minute cycles with an 18-yard payload of sand with high clay content—up to 270 yards an hour.

Here is just one of hundreds of examples where the power, speed and stamina built into the DW20G pay off on the job. You can count on it for high, steady production day in and day out.

With 345 horsepower stepping up rimpull 12%, the DW20G travels up to 20% faster than the previous model—even with the greater load capacity (19.5 cu. yd. struck) of the new 456B LOWBOWL Scraper.

Caterpillar SynchroTouch Transmission Control is optional—the operator simply dials the speed he wants. Split-second, touch-and-go response cuts cycle time—brings in more payloads per hour.

Call your Caterpillar Dealer and get the whole story on how the tough, dependable DW20G can step up production and profits on your jobs!

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

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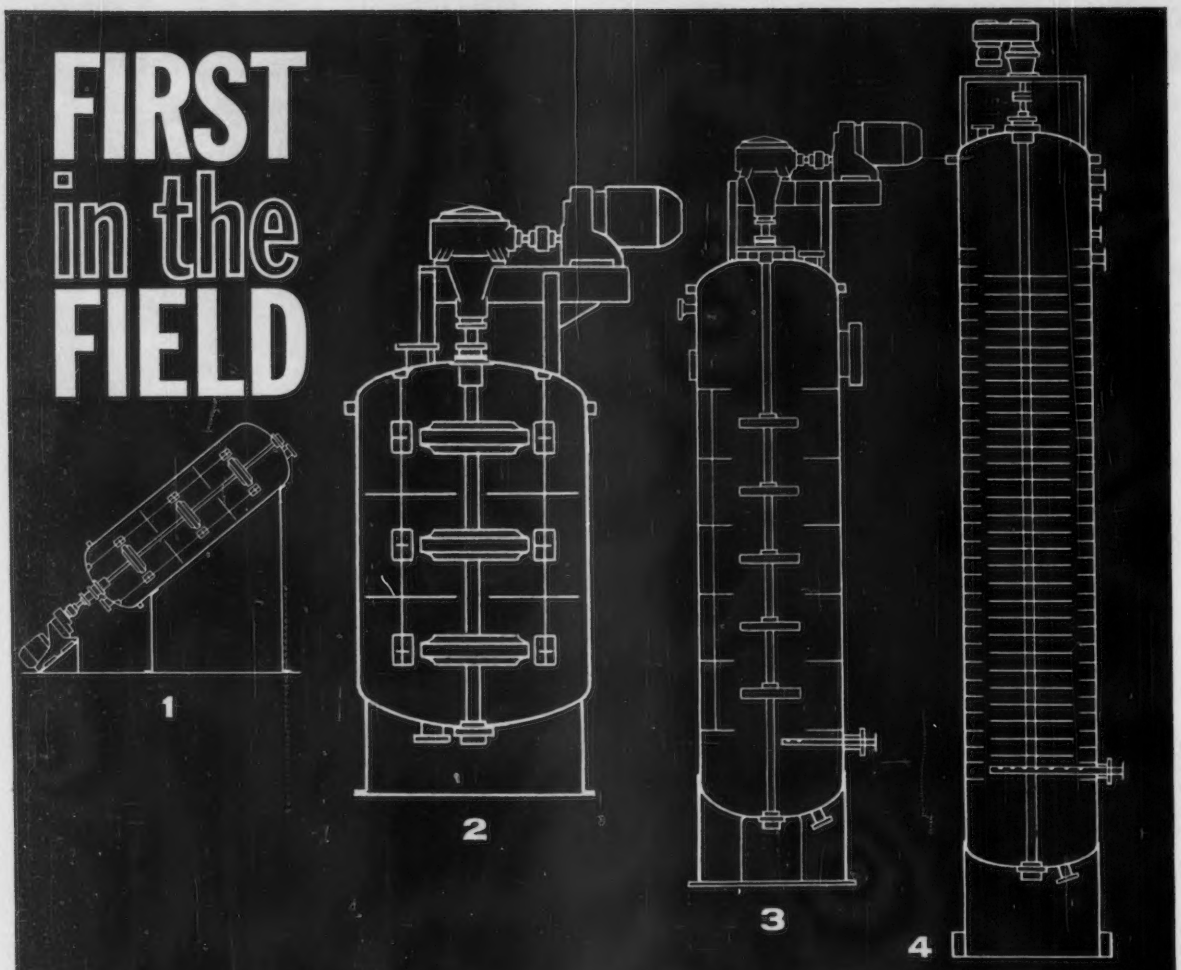
HAUL AT LOWEST COST PER CU. YD.

FIRST in the FIELD



1 First staged mixer (1933) supplied to industry. Designed and built by Turbo-Mixer.

2 Standard 3 stage concurrent mixer, supplied by Turbo-Mixer since 1[illegible]

3 Concurrent or countercurrent Turbo-Mixer reactor built in any size or number of stages.

4 RDC* column built by Turbo-Mixer. Latest word for countercurrent extraction.

STILL 1st WITH THE BEST

Staged mixing equipment is an old and continued story with Turbo-Mixer. From the first staged mixer, patented in 1933, through constantly improved concurrent and countercurrent equipment to the Rotating Disc Contactor, the staged mixing and extraction equipment preferred in most industries, General American's Turbo-Mixer Division has led the way. You may be sure General American research and industrial knowhow will maintain this leadership.

Write for Bulletins #T-11 and #T-1159 for descriptive details!

Process Equipment Division—Turbo-Mixers

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street
Chicago 3, Illinois

TURBO-MIXER GENERAL AMERICAN TRADE MARK

Offices in principal cities

A Progress Report on an important invention

H-W METALKASE REFRACTORIES

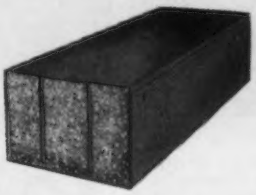
Initiated and continually advanced through numerous modifications by Harbison-Walker, these refractories contribute greatly to many noteworthy metallurgical developments.

Among all basic refractories, metalkase brick have superior spalling resistance. The metal casing and plating improve stress relief and appreciably reduce any peeling tendency.

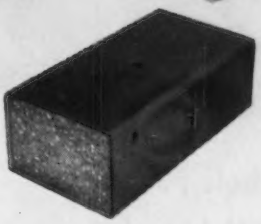
Metalkase brick are furnished in various sizes and shapes. They are made in both chemically-bonded and hard-fired basic refractories of various compositions which are used with particular benefit in suspended roofs and in walls in steel and nonferrous metallurgical furnaces.

METALKASE SUSPENDED ROOF ASSEMBLY. This composite basic brick roof shape is made with both hard-fired and chemically-bonded basic brick with interior plates—ready for use as received. Suspending member is inserted, turned through 90 degrees becoming automatically locked. Important benefits result from the prefired refractory in some applications.

TABKASE MAGNEX OHR XXP brick externally and internally plated have a stainless steel tab welded inside the insert which is flat with the end as shipped. At the place of use, they are bent to the upright position and hung back-to-back in place. This innovation in design contributes materially to long service and notable economy in parts of open hearth steel furnaces.



METALKASE XXP are chemically-bonded basic brick formed under high pressure with two internal plates. They are available in various compositions and are furnished in standard sizes and suspended arch and other shapes. METALKASE MAGNEX OHR most widely used in open hearth steel furnace roofs continues establishing unit roof life records. The high purity magnesia produced by Harbison-Walker from Michigan brines and stabilized as dense periclase is an important constituent which measurably enhances the desirable properties of this refractory.



METALKASE BRICK (externally plated), both hard-burned and chemically-bonded in various compositions, are made with either three or four-sided steel casings. Used for many parts of open hearth steel furnaces, for sidewalls and door jambs of electric furnaces and in other applications requiring high spalling resistance in basic composition, they very satisfactorily withstand extremely severe conditions.

EXKASE basic roof brick are made with patented four-sided welded cases provided with a bendable projection which insures proper expansion allowance. This automatic means of accurate expansion allowance avoids the need of burn-out spacers. With EXKASE, furnished in various key sizes for roofs, installation is simpler and costs less.

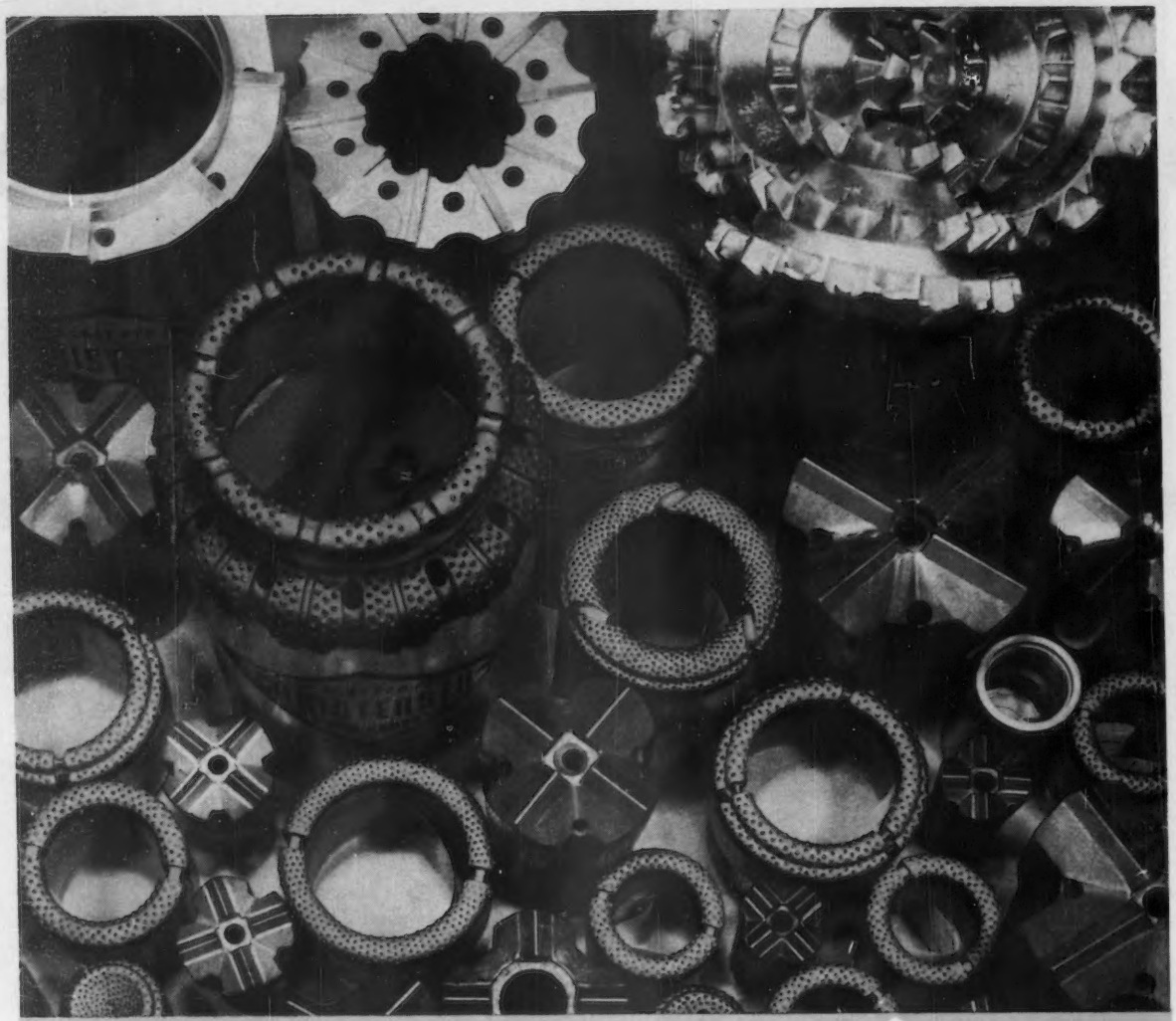
Other designs of metalkase include special shapes for patching, unusually large sizes, rotary kiln arch and wedge blocks, various suspended arch shapes and many others.

HARBISON-WALKER REFRACTORIES COMPANY

AND SUBSIDIARIES — **GENERAL OFFICES: PITTSBURGH 22, PA.**

® *World's Most Complete Refractories Service*

HW 60-24



If your problem is making hole . . .

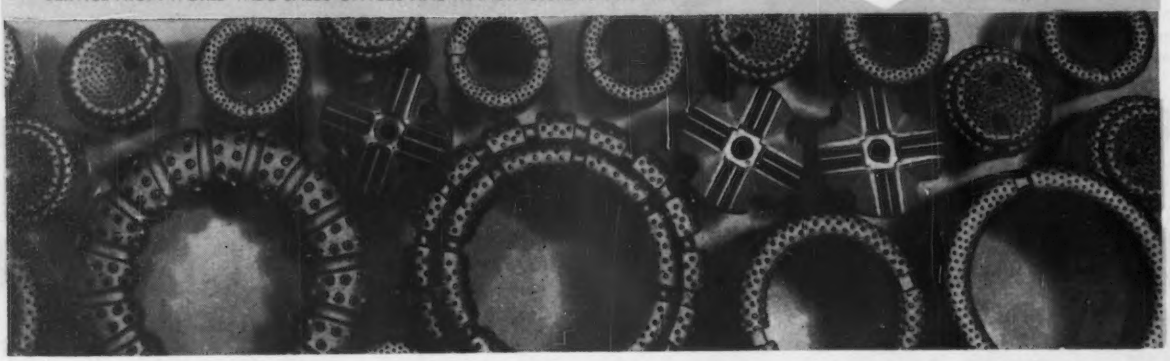
. . . Christensen offers a complete line of diamond bits, reaming shells, and core barrels. Also available are tungsten carbide and roller cone bits. When you need "complete" custom bit service, contact Christensen.

"Less cost per foot"

CHRISTENSEN DIAMOND PRODUCTS

MAIN OFFICE AND PLANT 1937 SOUTH 2nd WEST
SALT LAKE CITY, UTAH

SERVICE FROM WORLD-WIDE SALES OFFICES AND MANUFACTURING PLANTS



A Mack B-873SX diesel takes on a load of phosphate rock. Both trailers are belt loaded simultaneously from pre-charged bins, and the 75-ton payload is loaded and rolling in just a few minutes. Entire unit weighs 200,000 lbs. . . . covers 11 miles of specially built road from mine to processing plant at a top speed of 50 mph.

MACK
for over 7 straight years
NO. 1
by far in sales of diesel trucks

This Mack takes on

75-ton payload in minutes

From the time Morrison-Knudsen Company, Inc., at Soda Springs, Idaho, rolls one of its big Mack-drawn trailer trains under the loader till it pulls away with 75 tons of phosphate rock, only minutes have passed. Making continuous cycles over the 22 miles between mine and plant on each shift, five of these big, fast units have stockpiled thousands of tons of ore in a four-month period for a year of plant operation . . . performed like clockwork, requiring nothing beyond the most routine maintenance.

Dependable, efficient, thrifty performance is built into every Mack truck through the exclusive Mack manufacturing practice known as Balanced Design. It assures you of the most efficient, economical, trouble-free truck, made possible by matching components so exactly that they function as a completely integrated vehicle for maximum mileage life. To achieve Balanced Design, Mack—alone in the industry—designs and builds more of its vital truck components than any other truck maker.

Mack offers a wide range of vehicles to fit every assignment that calls for dependable trucks. Phone or visit your nearby Mack branch or distributor for complete details. Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario.

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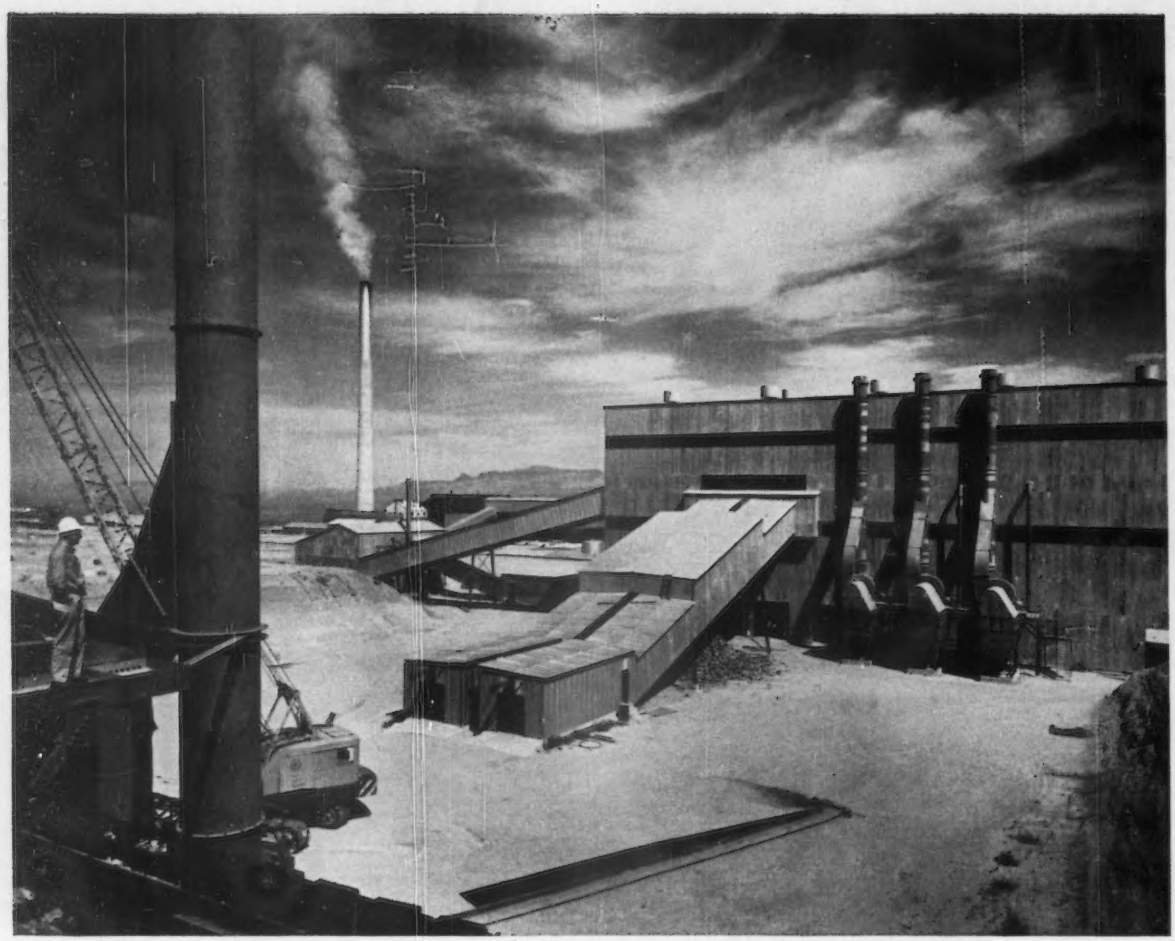


AAF ROTO-CLONES doom dust at this Southwestern copper mill

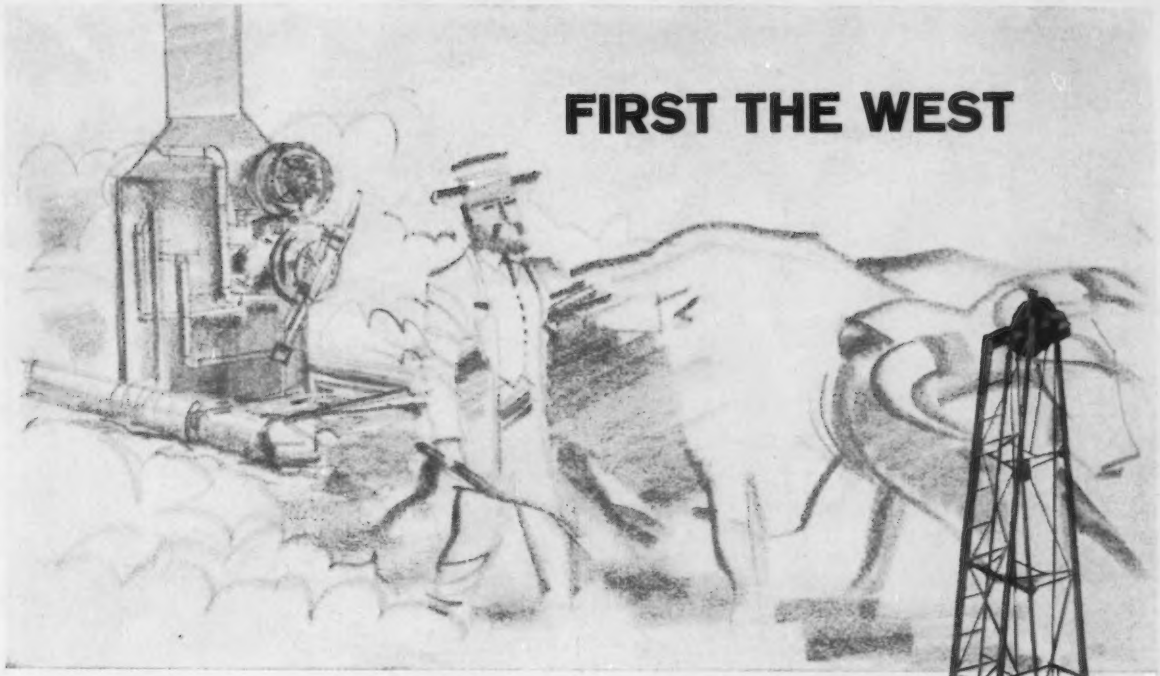
The only dust you can find around this large copper mill is that kicked up on the surrounding plain. Inside this plant (as in more than a dozen others), dust never has a chance. AAF Type N ROTO-CLONES whisk it away the very second it is created during crushing, screening, transfer and fine ore storage operations.

The high cleaning efficiency of the wet-collecting Type N results from the combined action of centrifugal force and the thorough intermixing of water and dust-laden air. Small space requirement, constant exhaust volume and maintained performance over a wide range of operating conditions—good reasons for specifying the Type N.

For complete product information, call your local American Air Filter representative or write for Bulletin 277. Address: Mr. Robert Moore, American Air Filter Company, Inc., 193 Central Avenue, Louisville 8, Kentucky.

AAF American Air Filter

BETTER AIR IS OUR BUSINESS



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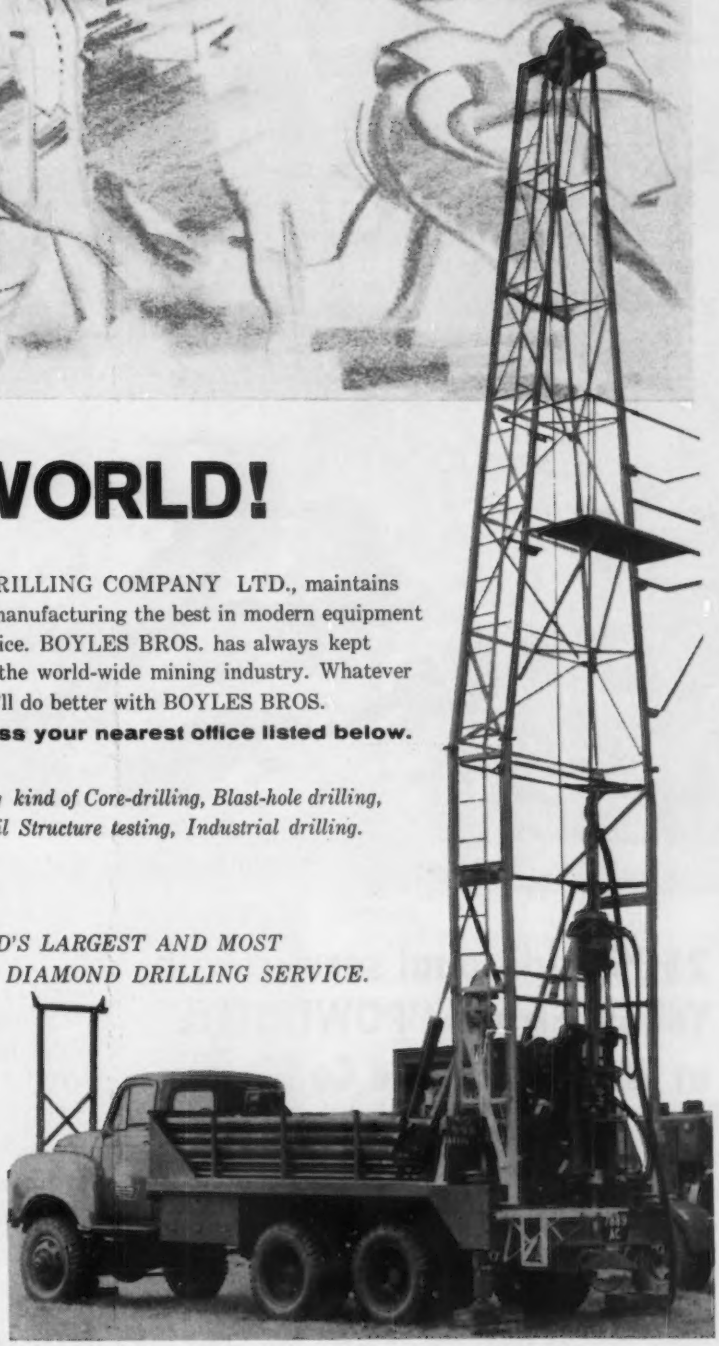

ATLANTIC GULF & PACIFIC COMPANY OF MANILA, MANILA, PHILIPPINES • DR. ALBERTO BIANCHI, MILANO, ITALY • CIA. "DIAMANTINA B.H." S.A., LIMA, PERU • DIMITRY SCALISTIRI, ATHENS, GREECE FORMAC S.A., RIO DE JANEIRO, BRAZIL • HAEHRE AND COMPANY, A/S, OSLO, NORWAY • ITEC, S.R.L., BUENOS AIRES, ARGENTINA • JOHANSSON & CIA., S.A., LA PAZ, BOLIVA • SHRIRO TRADING COMPANY S.A., TOKYO, JAPAN • G. WILLIAMS & CO. PRIVATE LTD., BOMBAY, INDIA • WIESE AND CA. LDA., LISBON, PORTUGAL

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25% additional service with Yellow Strand "POWERSTEEL" at Watauga Stone Co.

"Rugged" is the only way to describe the job of digging rough shot rock out of this Tennessee quarry. It takes rugged equipment to match the job and for this reason, Watauga Stone Co., Carter County, Tennessee, specifies Yellow Strand "POWERSTEEL" Wire Rope.

Hoist and crowd lines take quite a beating—they used to last 3 weeks on this big 2½ yd. shovel. Three years ago Watauga tried—and liked—Yellow Strand "POWERSTEEL" Wire Rope. They found Yellow Strand "POWERSTEEL" runs an average of 4 weeks—6 days per week, 8-hour shifts—between hoist and crowd rope changes. They report, "We're more than satisfied with Yellow Strand "POWERSTEEL."

25% longer life is an excellent average. B & B's extra high strength rope is designed for heavy loads and abrasive conditions. It's available right now from your Yellow Strand Distributor. Call him! *Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.*

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"POWERSTEEL"®
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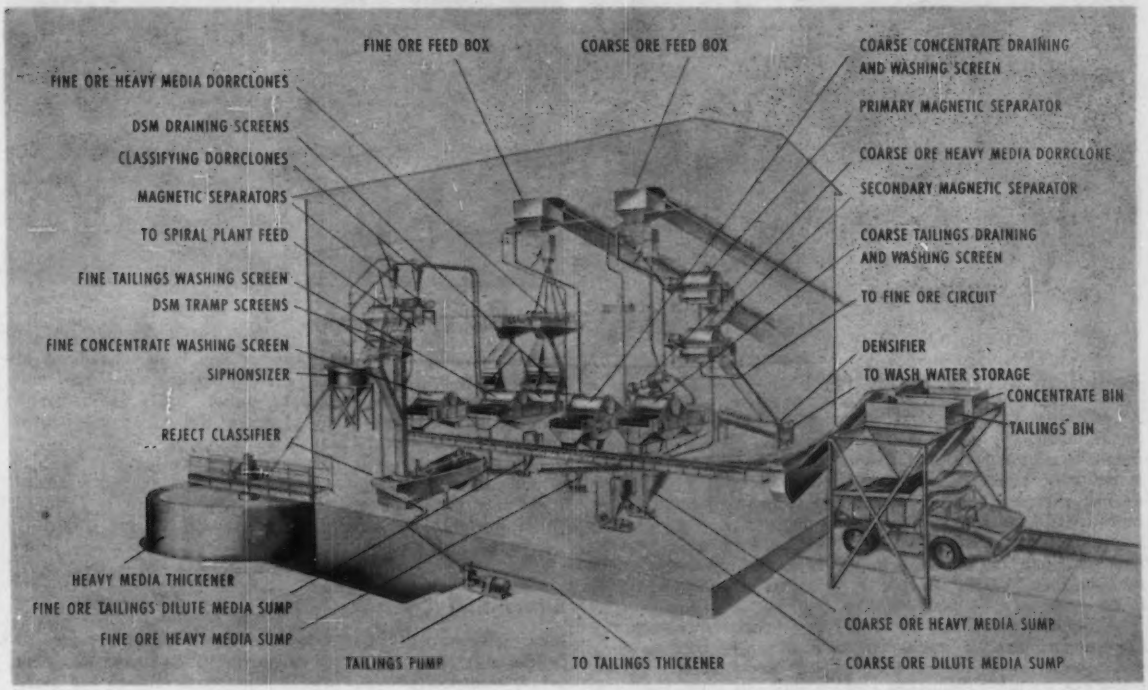


Low-Cost Wet-Cyclone Heavy Media Beneficiation Process (1)

DORR-OLIVER INC., Stamford, Conn., has developed a new heavy media process which, it is claimed, provides efficient, low-cost wet-cyclone beneficiation of ore in the full size range from —2½ in. to +65 mesh.

The process employs both DorrClone cyclones and heavy media ore classification units as separatory vessels in the media cleaning circuit. It utilizes a special, DSM screen for media draining and tramp service, and introduces a "SiphonSizer" classifier in media recovery.

According to the manufacturer, the process yields high operating efficiency, requires minimum floor space, and reduces media losses from 50% to 75% in comparison with heavy media processes now in use.

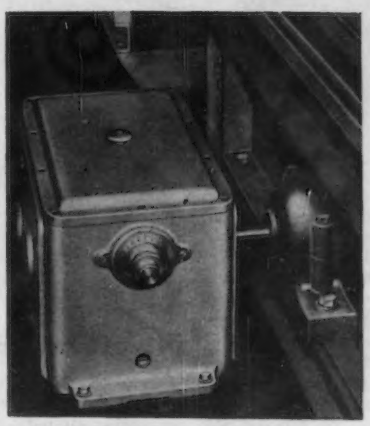
The flowsheet shows coarse (+¼ in.) and fine (—¼ in.) feed handled in separate circuits. Feed in each circuit is introduced under constant gravity head, thus eliminating ore from the media pump, reducing feed degradation, and increasing pump life. The effective separation gravity is automatically controlled by the DorrClone apex (underflow) discharge, which also compensates instantaneously for feed variables.

From this point on, the coarse ore circuit follows the conventional heavy media flowsheet.

The fine ore circuit, however, provides for separation of media from both tailings and concentrate by the DSM screen, resulting in recovery of cleaner, less viscous media, and in improved metallurgy. The DSM screen oversize is sent to wash screens, from which the oversize is sent to concentrate and tailing piles.

Wash screen undersize is classified in DorrClone cyclones, from which the coarse fraction (underflow) is magnetically separated and cleaned. Since the magnetic cleaning circuit handles only a small portion of the dirty media, separator efficiency is increased; in one installation, magnetic separator requirements were reduced from 40 linear feet to 13 linear feet. Cyclone overflow is magnetically flocculated and hydraulically cleaned in the SiphonSizer. The SiphonSizer is a new, simplified, hindered-settling classifier which permits automatic discharge and low pressure water operation, with no moving parts. Its underflow is thickened for return to the heavy media circuit.

The flowsheet is based on iron ore beneficiation. The process can, however, be adapted to a wide variety of applications.



Constant-Torque Design (6)

THE BRITISH FIRM, Fairbairn, Lawson, Combe and Barbour Ltd., Leeds, has introduced a novel-design transmission, which provides constant-torque output-shaft speed under widely differing temperature, humidity, and atmospheric pressure conditions. Its trade name is CONtorq.

The unit operates from an input speed of 450 rpm, with an output speed range of from zero to 50 rpm. An auxiliary motor can be flanged to the input side, and a number of optional attachments to the output side. The latter include worm or wheel units, bevel drives for direction changes, or differential attachments which allow selection of output speeds in any 100 rpm range, such as from zero to 100 rpm, or 900 to 1,000 rpm. Speed changes are made by turning a graduated knob.

CORRECTION

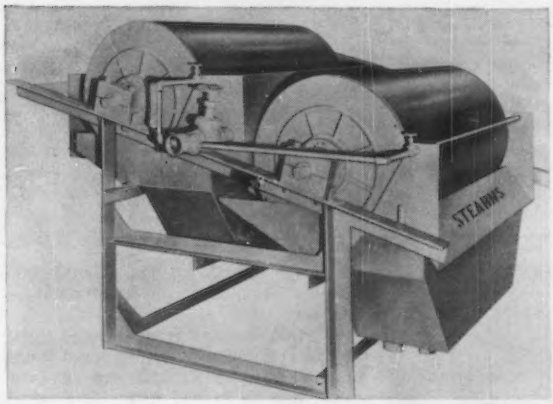
Two errors appeared in the New Products Digest section for November. On page 49, item 15, the company's name should read "Draft-All Triangle Co." And, on page 50, item 34, the company's name is "Amperex Electronic Corp."

Radiation Survey Meter (9)

A SHOCKPROOF, watertight, transistorized radiation survey meter, made by Gelman Instrument Co., Chelsea, Mich., measures alpha, beta, and gamma radiation. The instrument is portable, operates on 2 flashlight batteries, is stabilized against changes in both voltage and temperature, and has a built-in loud-speaker and earphones.

The meter's counter has a 275°, 4¼ in. long scale for ease and accuracy of reading. It will operate in temperatures ranging from —22°F to 125°F, with an accuracy of 15%, in two ranges: 0-10 and 0-200 mr/h.

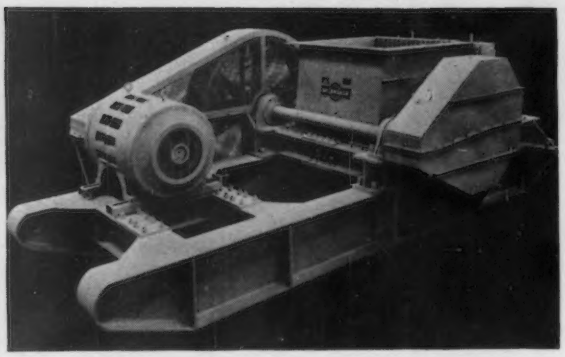
The geiger probe may be stored in a special shock-absorbing compartment. An extra compartment can be used to store spare batteries or spare probe. Neoprene-protected geiger tubes are interchangeable. Battery condition is indicated by a neon light. Female plugs permit attachment of power supply, for on-line current use in a laboratory.



Ceramic Magnet Separator (4)

A PERMANENT ceramic magnet wet drum separator, designed for cobbing applications in the concentration of magnetite and reduced hematite ores, has been developed by Stearns Magnetic Products, Milwaukee. The double-drum, concurrent style units employ a ceramic magnet material, Indox V, which provides field strength readings of up to 850 gauss 2⅜ inches from the magnet face.

According to the manufacturer, the high-strength ceramic material provides significant savings in weight and in operating and maintenance costs. Construction features of these new separators include the use of non-magnetic, corrosion-proof stainless steel for the feed box and collection tank, and a special wear-resistant cylinder material. The units have 36 in. diameter cylinders, with a choice of 24, 36, 48, 60, or 72 in. magnet widths. Other similar wet-drum units are available for both roughing and finishing service in ore concentration applications.



Movable Crusher (13)

A NEW skid-base, movable crusher has been introduced by McLanahan and Stone Corp., Hollidaysburg, Pa. The unit includes a self-contained, 100 hp motor, and a 36 in. by 48 in. McLanahan Black Diamond Single Roll Crusher mounted on a heavy-duty skid base.

Design includes split frames on the crusher and skid to allow passage through very narrow vertical shafts. A chain-flight unit feeds the crusher, while crushed ore is removed by a portable belt conveyor. The machine was originally developed for use in a salt mine.

Single-Roll Crusher (10)

NEW SINGLE-ROLL CRUSHER with relatively large capacity to handle soft slate, shale, phosphate rock, limestone, etc., but which incorporates many design features developed for more severe-duty crushers, was recently introduced by The Pennsylvania Crusher Div., Bath Iron Works Corp.

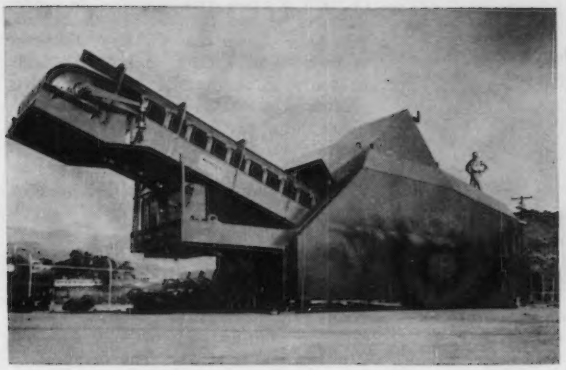
The new Atlas unit reduces product size to maximum dimensions of 1½ to 8 in. It's available with roller diameters of 18, 24 or 30 in. to handle feeds up to 26-in. thick.

According to the company, the new crusher incorporates the following design features: contoured breaker plate to take the large feed sizes without clogging; simple, trouble-free adjustment of breaker plate by shims to set product size; automatic toggle and torsion spring safety release to prevent dammage from hard, uncrushable matter; and spherical, anti-friction roller bearings mounted in split housings outside the crusher frame where they are easily lubricated and inspected.

New Shuttle Car (18)

GOODMAN MFG. CO. has come out with a new, improved AC shuttle car which they say has greater capacity, power and structural strength.

Goodman's car (either 44 or 49 in. high and 96 or 100 in. wide) can transport 13 tons of rock, a payload that can be increased with the addition of 6-in. or 12-in. sideboards. An 80-hp traction motor with two sets of windings provides for two-speed operation (2½ or 5 mph) without using clutches and torque converter.



High-Capacity Belt Loader (16)

MASSIVE (32 ton) mobile belt loader capable of pouring material at 3,500 tph has been introduced by Western Conveyor Co. It can be run by a two-man crew.

A belt that runs continuously and internal hydraulically-operated gate control and feeder are two features unique to the improved loader, Western officials said. Since the 60-in. belt runs continuously, shear and starting load are eliminated—belt can therefore be easily driven by a 75-hp motorized pulley. The discharge gate and feeder positive hydraulic cut-off prevents material dribbling or spilling between loading discharges.

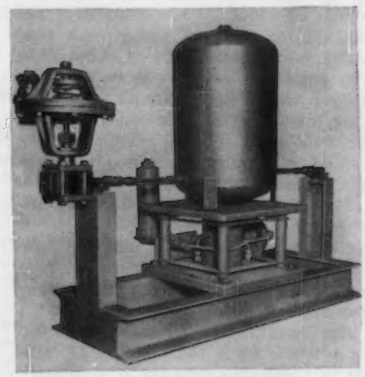
Western has put the fifth wheel pin under the discharge end in such a way that a truck can hook up and move the unit without it first having to be crane-lifted.

LW Hydraulic-Control Tractor (2)

LETOURNEAU-WESTINGHOUSE CO., Peoria, Ill., has announced a Tournatractor with hydraulically operated attachments as a companion unit to its electrically controlled model.

The machine utilizes a high-pressure hydraulic system of 5,000 psi (most other systems are 1,500 to 2,000 psi). Two slide valves in the control system permit immediate pressure build-up and fast, positive blade response.

The tractor is powered by a new, 218 hp engine, has a power-shift transmission, 4 speeds forward, and a top speed of 18.5 mph. Another new feature is an integral, 1,400 rpm power take-off, for use with a double-drum power-control unit in operation of towed equipment. The Tournatractor's over-all length is 13.5 ft, without the blade. Over-all width is 10.5 ft.



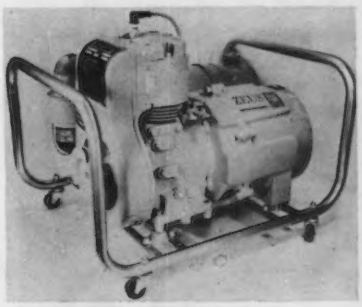
Specific Gravity Measuring System (11)

A CONTINUOUS, in-process specific gravity measuring system has been developed by Weighing and Controls, Inc., Hatboro, Penna. Designed for use with liquids, solutions, slurries, suspensions, emulsions, whips and creams, the equipment operates without radioactive devices or mechanical transducers. Its output signals can be used for indication, recording, or control purposes.

A flexure-mounted W & C pneumatic weight transmitter, coupled with a specially designed stainless steel tank, (above) continuously weighs a constant volume of a slurry or liquid, and gives readout directly in specific gravity units.

Volume is kept constant by one of two methods. If the material contains air, a probe and an air-vent valve maintain the liquid level by venting the top of the tank. Liquids not containing air can be measured in an open-top, overflow tank. In both tank designs, turbulence can be introduced by baffles so that contained materials remain in suspension. A motor mixer may be attached to the tank for agitation.

Accuracy is claimed to be better than 0.25% over-all, and repeatability to be one part in 2,000. The pneumatic signal output gives wide flexibility and range, with output pressure of from 3-15 psi or 5-40 psi, read on a scale calibrated to 0.1%. The signal is stepless, giving smooth control.



Portable Generator (12)

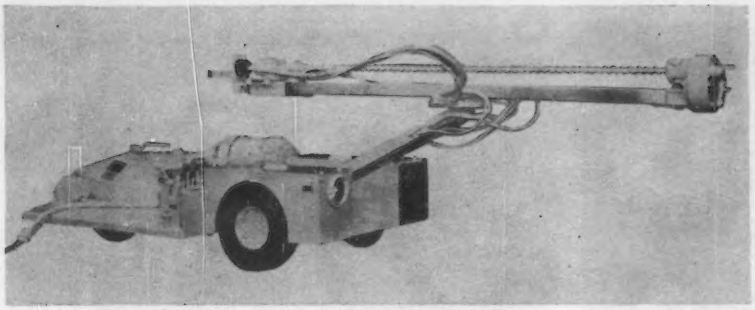
BORG-WARNER CORP. now offers a light weight, heavy-duty portable electric generator with a 3,000 watt AC power rating. Trade-named "Zeus," the generator will provide packaged emergency power in remote job-site areas.

A permanent magnet alternator, developed by B-W for use in jet aircraft, permits power generation by a permanent magnet rotating field. This eliminates brushes, slip rings, and commutator. The permanent magnet, internally fan-cooled and corrosion protected, connects directly to the engine shaft with no coupling.

The Zeus Model GW-300 is rated at 3,000 watts, 115/230 volts, 60-cycle, single phase. Powered by a rope-started (electric starter optional), 1-cylinder, 4-cycle, air-cooled gasoline engine, the unit will operate for approximately five hours of full load running on a fuel tank capacity of 2¾ gal. An exhaust extension is available, for use in confined spaces. A positive action fuel pump permits connection to a larger, auxiliary fuel tank. The generator may be adapted to use butane or propane gas. There are three power outlets: one 230 volt twistlock and two 115 volt 3-prong sockets.

Snap-on Conduit Strap (5)

INSTALLATION of pipe, thinwall, and rigid conduit is simplified by a Two-Hole Strap made by Holub Industries, Inc., Sycamore, Ill. Made of zinc-coated spring steel, they will take up to 1,177 lb tension.



"Rotary Thrust" Mobile Drilling Machine (3)

PARALLEL DRILLING of ore seams as low as 28 in. from the floor and as high as 2½ in. below the roof is possible with the TDF 10 Mobile Coal Drilling Machine, according to its manufacturer, Long-Airdox Co., Oak Hill, W. Va.

The new machine applies rotary thrust to the auger within 1 ft of the working face, through a combination of thrust and ball bearing guides in the drill head. This arrangement reduces torque strain.

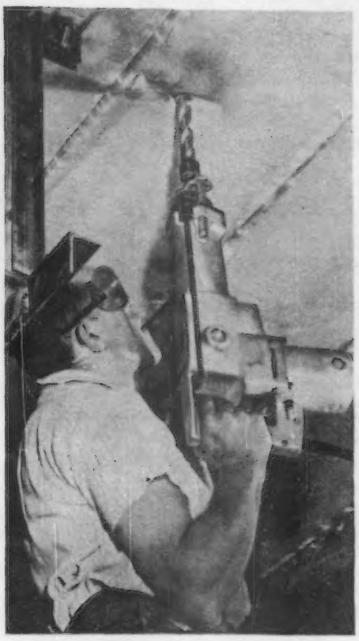
Auger feed rate may be varied from zero to 33 fpm by a foot pedal, and the machine will drill 9 ft holes in from 12 to 15 sec.

Trials have shown that the drill enables one man to both drill and shoot. The highly mobile machine permits "multiple Airdox" shooting, whereby a series of reusable tubes are inserted in drilled holes and shot in sequence with extremely high-pressure air. The air forces through discharge ports under pressure, stimulating a progressive erosion and chipping around the tube and away from the working face. When pressure is released, the ports twist shut automatically, thus eliminating the task of resetting rupture discs in tube perforations, as was previously necessary. The multiple Airdox shooting method eliminates the need for explosives and facilitates loading and cleaning of broken coal.

Magnetic Bin Vibrator (15)

A MAGNETIC BIN VIBRATOR produced by the Eriez Manufacturing Co., Erie, Pa., regulates the flow of materials through large bins and bunkers effectively and with minimal noise. The vibrator's hammer gives equivalent of 7,200 sledge hammer blows per minute against a bin wall, preventing material from sticking or bridging at constricted points. Semi-resilient elements cushion hammer impact within the vibrator and permit relatively quiet operation.

Vibrator units can be bolted easily on walls up to ½ in. thick, at points where materials tend to clog. For bins with less than 50 ton capacity, a single unit should suffice, according to the manufacturers. The vibrator operates from a 60 cps line without a rectifier or special wiring. Shown are two models, illustrating the size range available.



Triple Action Drill-Hammer (7)

SKIL CORP., Chicago, offers its electric Roto-Hammers in two sizes, each of which will do three distinct operations: hammering with simultaneous power rotation, hammering without rotation, or drilling without hammering. The manufacturer claims that tests with carbide bits have shown that the Roto-Hammer is capable of drilling a ¾ in. hole in masonry three times faster than other electric hammers.

On tests made drilling 1,000 holes, each ¾ in. by 4 in. deep, with a single carbide bit, material and labor cost-per-hole was nine cents. Total drilling time was 19 hours and 23 minutes, or slightly over one minute per hole.

The three-way operation is effected by a combination of electro-pneumatic drive and a constantly rotating inner barrel. Hammering action is provided by air pressure built-up in a cylinder between a piston and a striker. The compressed air serves as a cushion, and prevents piston-striker contact. There are no springs or connecting parts between piston and striker.

The tool may be used with a flat-tip carbide bit for rapid setting of roof-bolt anchors and expansion shields. A built-in gage assures uniform hole depth at any setting chosen by the operator. The Roto-Hammer has been designed for use in concrete, metal, or wood.

New Design Plunger Pump (14)

BARRY PUMP CO., Tulsa, announces a unique suction and packing design for its new line of V-60 quadruplex plunger pumps. Packing is non-adjustable, and is held in place by the pump's rigid metal body, eliminating packing flow. The pump has replaceable packing cartridges which permit quick and easy change in plunger size without changing the fluid head. Valves are placed low, so that fluid being pumped never stops or changes flow direction.

The pumps will handle fluids of viscosity up to 30,000 Saybolt Universal Seconds at normal speed, and will handle light hydrocarbon fluids at high volumetric efficiency, without pressurized suction.

The manufacturer states that pumps are available from 150 to 1,250 hp, with 100 to 1,300 gpm capacity, in 8 models. Among other uses, the pumps are adapted for use in drilling, hydraulic fracturing, water flooding, and handling of light hydrocarbons, petrochemical products, and slurry.

Control Instruments (6)

NUCLEAR-CHICAGO CORP.'s Industrial Division has developed four new "Qualicon" instrumentation systems which provide for continuous measurement and control of (1) the bulk density of solids on a conveyor or in a bin or hopper (model 502), (2) the percent moisture of solids on a belt or in a storage facility (model 507), (3) the specific gravity of solutions and slurries in pipes or tanks (model 504), and (4) the percent moisture of liquids or slurries in a process loop or tank (model 509).

Each system utilizes nuclear methods of radiation measurement, and can be provided with either analog or digital presentation and control.

For Your Files

This selected manufacturer's literature is free unless otherwise specified. If item is for sale, send request and money direct to manufacturer.

AIR-WEIGH SYSTEMS for inventory control, mixing and batching, and solids flow control, are described in a four-page bulletin from the Harrob Industries. **(84)**

SPECIFICATIONS and working load limits of a new line of alloy chain slings, rings, links and hooks are presented in a 16-page brochure from the Wire Rope Div., Jones & Laughlin Steel Corp.

Included in the brochure are tips on how to use and maintain chain slings and their attachments, as well as an outlined link-by-link periodic inspection program. (85)

TELEVISION CAMERAS, monitors, receivers, lenses and accessories plus an outline of various industrial applications for all the equipment are described and illustrated in a 16-page booklet from the Motorola Communications & Electronics, Inc. **(86)**

AIR POLLUTION FOUNDATION has published a 20-page leaflet which studies the problem of air pollution in general and smog in particular. In clear, easy-to-understand terms, the Foundation discusses the various air pollutants, what one particular city, Los Angeles, has had to do to keep a check on run-away smog conditions, and finally gives a list of available Foundation literature with price list. **(87)**

A 10-PAGE DISCUSSION of geophysical reconnaissance, called "The Refraction Method of Seismic Prospecting", has been prepared by the Electro-Technical Labs.

After briefly reviewing the two methods of seismic exploration, reflection and refraction, Electro-Technical discusses the refraction method in detail (seismic refraction shooting, field procedure, applications of the refraction method to mining). **(88)**

MINE SAFETY APPLIANCES CO. has issued a 40-page catalog (No. 0300-1) of gear for eye and face protection for a wide variety of industrial applications.

Included in the new release is the company's Sightgard line of eyewear which combines maximum protection with functional design. **(89)**

HARBISON - WALKER REFRACTORIES CO. has published a new, eight-page brochure which reviews the principal brands of fireclay refractories produced at their Ione, Calif., plant. **(90)**

ELABORATELY PREPARED 18-page Bulletin 660 from McNally Pittsburg Mfg. Corp. gives a broad review of the company's cradle idler and belt conveyors.

Included and illustrated in the presentation are: idler H-frames; skirt plates; conventional type idlers; self-aligning idlers; conveyor drives; pre-engineered belt conveyor sections; and belt conveyors using wire rope stringers. **(91)**

HYDRECO GEAR PUMPS, control valves, and motors, and their application on mobile equipment and production machinery, are the subjects of a new bulletin (No. 10-001) published by the Hydreco Div., New York Air Brake Co. **(98)**

GLOSS-STOCK fold-out describing a complete new line of Safety-Weave synthetic web belt slings has been published by the Wire Rope Div., Jones & Laughlin Steel Corp. **(92)**

A 36-PAGE CATALOG that gives complete specifications and information on a full line of conveyor, elevator and transmission belting has been prepared by the Boston Woven Hose & Rubber Div., American Biltrite Rubber Co. In addition to the detailed data, the company said, the catalog shows the construction of each belt in cross-section. **(93)**

REVISED 1960 SPECIFICATIONS for testing sieves, embodied in the A.S.T.M. specification E-11-60-T, has been prepared in bulletin 608 by The W. S. Tyler Co.

The new specifications combine the former coarse and fine series into a single series. **(97)**

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1	11	21	31	41	51
2	12	22	32	42	52
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WILSON MECHANICAL INSTRUMENT DIV., American Chain & Cable Co., recently published a catalog which they claim eases the choice of getting the proper hardness tester for any given application.

The catalog describes the Rockwell hardness tester and the TUKON microhardness tester and also illustrates several models designed for specific uses—fully automatic models, motorized models, those for testing at high temperatures, internal hardness testing, etc. **(95)**

FLEXIBLE SHAFT HANDBOOK, in a completely revised fourth edition, is available from the S. S. White Industrial Division.

The neatly-indexed guide is a simplified approach to the selection of flexible shafting—standard, pre-engineered, or custom-designed. For the first time, the company gives data on a new, simplified system based on integral formed square drives, and the new, improved Series 7 (remote control) and Series 9 (power drive) flexible shafts. **(100)**

NEW FOUR-PAGE BULLETIN from Materials Handling Department, Dravo Corp., outlines their standard line of rotating discs for pelletizing or mixing ore fines, phosphates, ceramic clays, fly ash and oxides.

The bulletin cites design features and advantages of the Dravo discs, which range in dia from 39 in. to 16 ft-5 in. and lists typical capacities. **(96)**

ADAMAS CARBIDE CORP. has prepared a new 36-page price list and specification guide (No. 960) for their complete line of tungsten carbide tools, tool dips, dies, wear parts and Dex-A-Tools. **(99)**

UNIT MODEL 614, a ½-yd. excavator-crane convertible to dragline, trenchoe, clamshell, and magnet attachments is reviewed in a 12-page catalog from Unit Crane & Shovel Corp. **(94)**

HYDRO-FILTER—a wet scrubbing tower for maximum dust collecting performance—is being used in many ore refining and foundry plants according to a six-page bulletin from National Dust Collector Corp. **(83)**

NEW 16-PAGE CATALOG from Hardinge Manufacturing Co. (subsidiary of Hardinge Co. Inc.) describes the company's various tools and fabrication facilities.

Their foundry pours both "Meehanite" and "Ni-Hard" metal, specializing in pit-molded castings. The assembly department specializes in custom-made machinery. **(78)**

AVAILABILITY of 12-page catalog 300-C3 on Commercial TH yieldable arches has been announced by Commerical Shearing & Stamping Co.

Describing the principle of yieldable arches for underground support and how they work, the bulletin lists six exclusive Commerical TH yieldable arch features, complete technical information on segment and connection details, typical arch shapes, accessory details, dimensions, and physical properties of Commercial lagging used in conjunction with the arches. **(79)**

DEAN BROTHERS PUMPS INC. has published a new 12-page selection catalog for users of centrifugal pumps.

Included in this condensed, easy-to-use circular are charts showing the recommended temperature and pressure ranges for ten classifications of Dean Brothers Pumps—from minus 350°F to plus 1000°F and up to 1000 psig. Illustrations, brief descriptions and specifications are shown. **(80)**

NEW EIGHT-PAGE CATALOG covering shuttle cars for use in low and intermediate height seams in underground mines has been published by Goodman Manufacturing Co.

Operating on AC or DC current, the shuttle cars can load onto conveyor belts or into mine cars. **(81)**

WEIGHT COMPUTATIONS for welded steel tubing are easily obtained from tables in a new brochure prepared by the Electricweld Tube Div., Jones & Laughlin Steel Corp.

Tables in the handy 16-page brochure give dimensions and weight per ft for round mechanical tubing up to 10 in. square and rectangular tubing up to 5 in., and pressure tubing up to 5 in. A full-page table gives decimal equivalents for fractional parts of a pipe foot. Another table presents diameters and weights for pipe sizes. **(82)**

NEW BOOKLET, "Why Diesels for Small Trucks," published by Detroit Diesel Engine Div., General Motors Corp., gives charts by means of which operators can estimate cost advantage of converting to diesels, according to the company. Included are reports from operators who have made the conversion. **(77)**

E&MJ NOT GOOD AFTER JUNE 1, 1961 **DECEMBER 1960**

Please send me the catalogs or further information about the items from New Products Digest whose numbers are circled.

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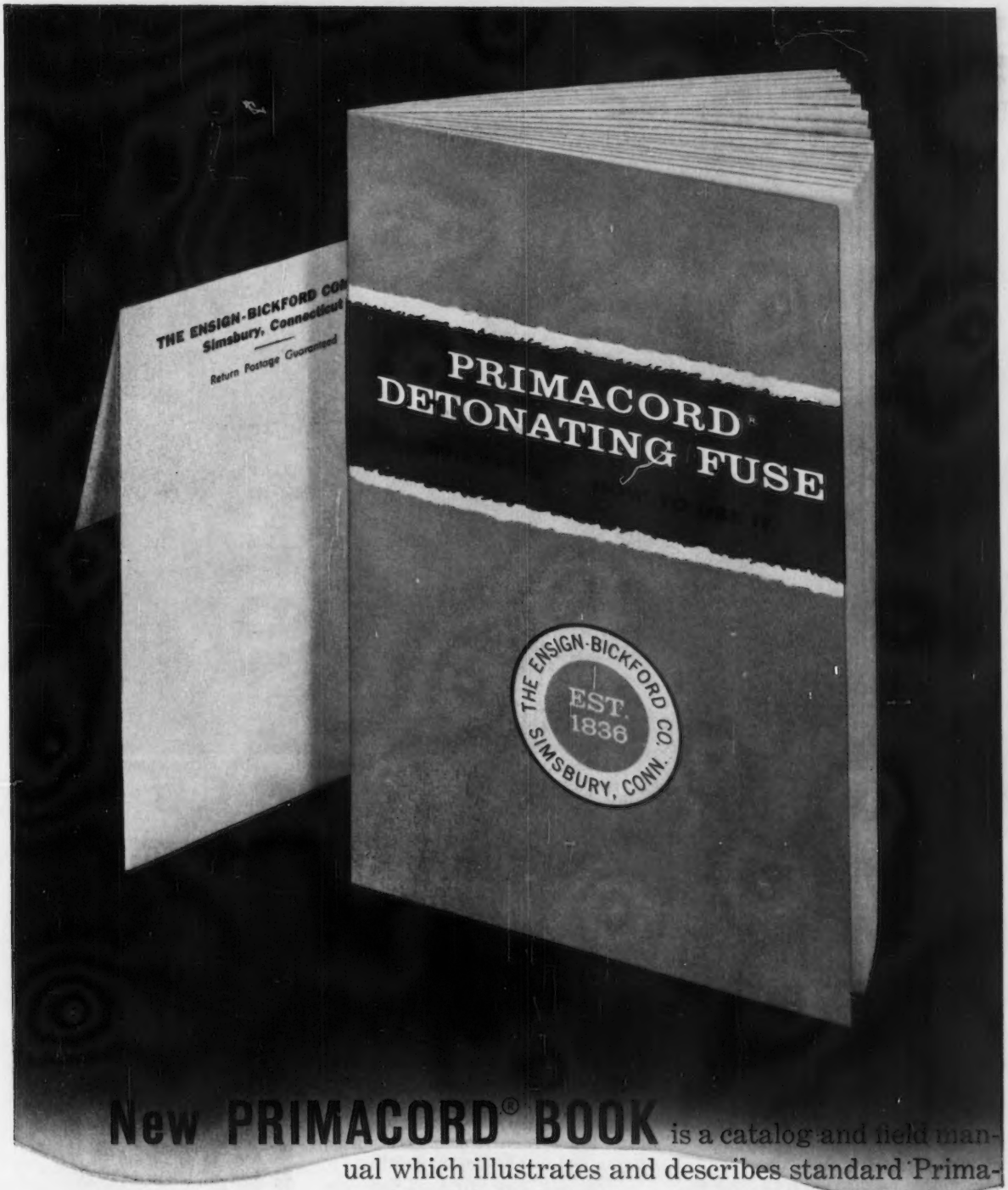
PLACE REQUIRED POSTAGE HERE

McGRAW-HILL PUBLISHING COMPANY, INC.

ENGINEERING & MINING JOURNAL

330 WEST 42nd STREET

NEW YORK 36, N. Y.



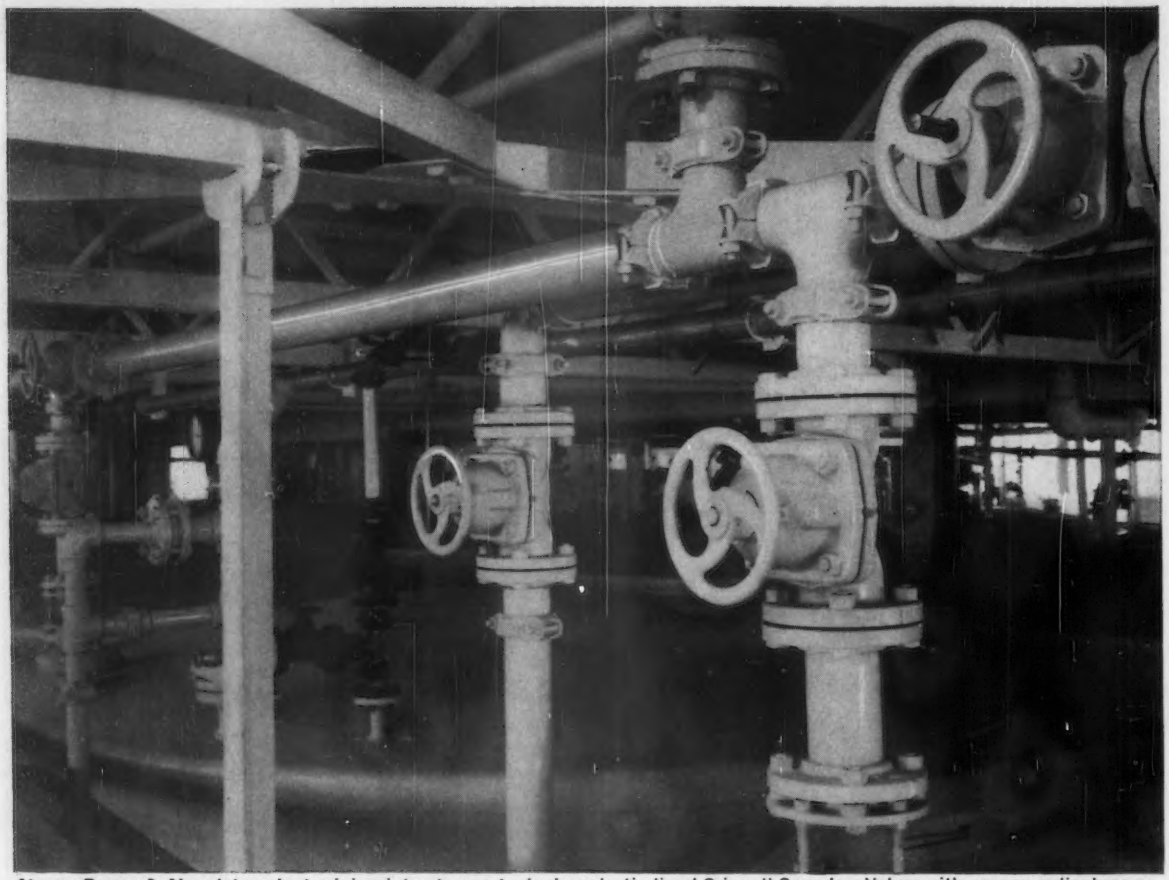
New PRIMACORD® BOOK is a catalog and field manual which illustrates and describes standard Primacord brands and tells how to use this detonating fuse to obtain better blasting with greater safety and profit—in mining, quarrying and construction work.

Ask your explosives supplier for a free copy or write to Sales Department

THE ENSIGN-BICKFORD COMPANY

Simsbury, Connecticut **Since 1836**

P-6



At new Dewey & Almy latex plant, piping into storage tanks has plastic-lined Grinnell-Saunders Valves with neoprene diaphragms.

At Dewey & Almy plant...

Grinnell-Saunders Diaphragm Valves guard against plugging, corrosion, contamination

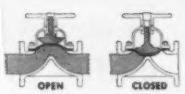
The new Owensboro, Kentucky plant of Dewey and Almy Chemical Division, W. R. Grace & Co., makes polyvinyl acetate emulsions and butadiene-styrene co-polymers for adhesives, paper coatings, emulsion paints and other products.

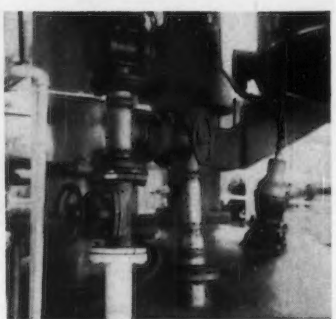
These co-polymers present several manufacturing problems: build-up of obstructions that plug lines, high viscosity that needs wide-open lines, easy hardening by the air.

Selected to handle this tough job: *Grinnell-Saunders Diaphragm Valves.* These rugged valves have a diaphragm that lifts high for streamline flow; seals tight for positive closure. Bonnet mechanism is completely isolated from material in the line by the diaphragm to prevent corrosion and contamination.

What's more, Grinnell-Saunders Diaphragm Valves give smooth passage of material . . . eliminate trapping of solids, reduce frictional resistance. You can choose from a number of body, lining and diaphragm materials.

Find out how Grinnell-Saunders Diaphragm Valves can help *your* installation. Write Grinnell Company, Providence 1, R. I.





Grinnell-Saunders Valves with stainless steel bodies and teflon diaphragms were specified for the reflux lines of this co-polymer reactor.

GRINNELL-SAUNDERS DIAPHRAGM VALVES

GRINNELL COMPANY, PROVIDENCE 1, R. I. • BRANCH WAREHOUSES AND DISTRIBUTORS FROM COAST TO COAST
PIPE FITTINGS • VALVES • PIPE HANGERS • PREFABRICATED PIPING • UNIT HEATERS • PIPING SPECIALTIES

product:

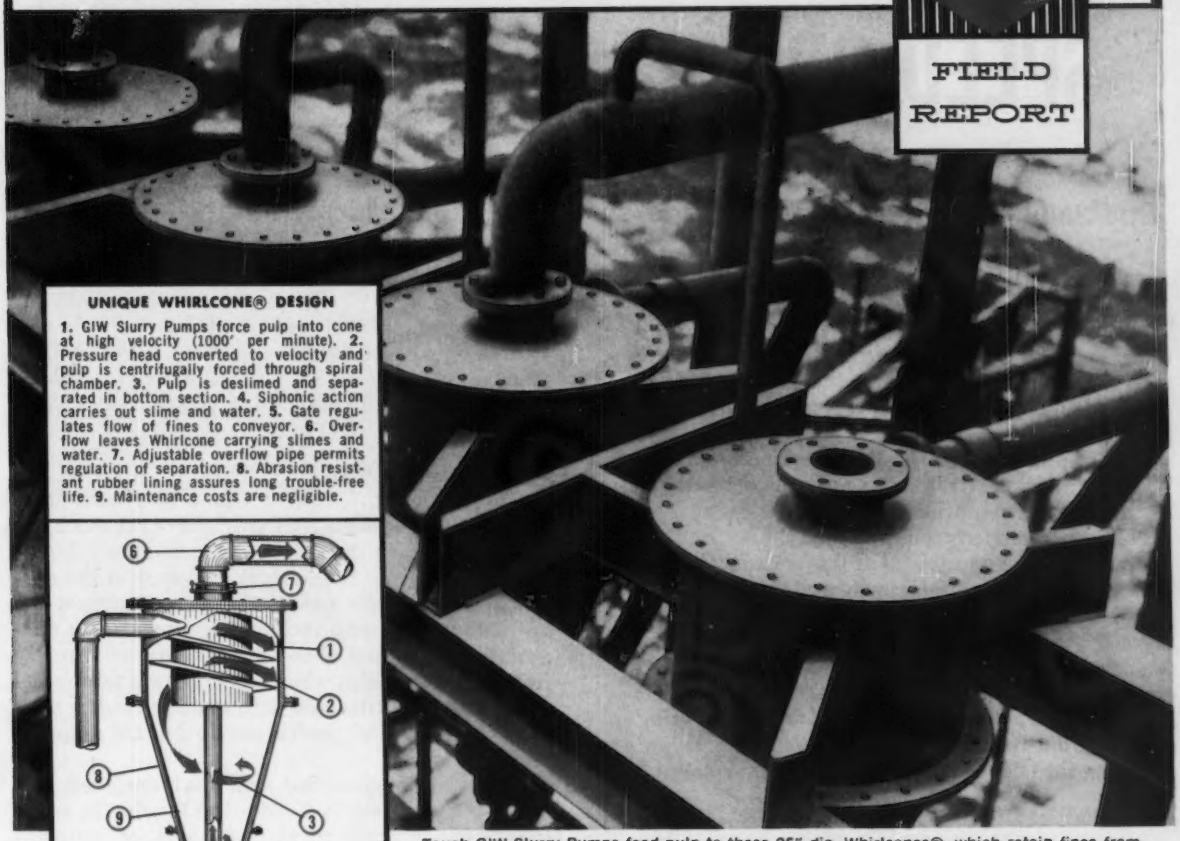
COTTRELL WHIRLCONE® SEPARATORS

customer:

BECKER COUNTY SAND & GRAVEL CO.

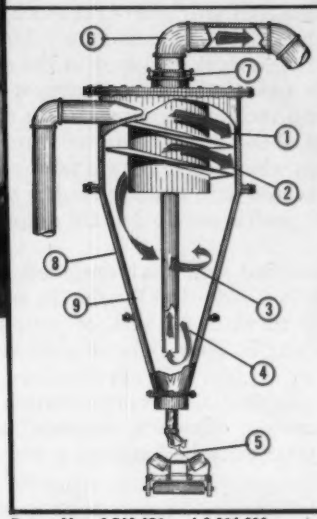
GIW

FIELD REPORT



UNIQUE WHIRLCONE® DESIGN

1. GIW Slurry Pumps force pulp into cone at high velocity (1000' per minute). 2. Pressure head converted to velocity and pulp is centrifugally forced through spiral chamber. 3. Pulp is deslimed and separated in bottom section. 4. Siphonic action carries out slime and water. 5. Gate regulates flow of fines to conveyor. 6. Overflow leaves Whirlcone carrying slimes and water. 7. Adjustable overflow pipe permits regulation of separation. 8. Abrasion resistant rubber lining assures long trouble-free life. 9. Maintenance costs are negligible.



Patent Nos. 2,738,070 and 2,806,599

Tough GIW Slurry Pumps feed pulp to these 25" dia. Whirlcones®, which retain fines from classifier overflow. Maximum recovery rate is 20 tons per hour per cyclone. The cones will handle material from −12 mesh to lightest slime.

Whirlcone® Separators solve difficult fine recovery problems.

The retention of fines in the −50 plus 200 mesh range posed a disturbing problem for the Becker County Sand & Gravel Co., of Cheraw, S.C., primarily because the large amount of water used in processing the sand and gravel washed out the desirable fines with the minus 200 slimes.

Fourteen 25" dia. Whirlcone® wet type cyclones installed parallel in four Becker plants solved this problem completely. Operating an average of 8 hours daily, they extract up to 100 tons of clean, fine sand per hour from wash water while the minus 200 mesh slime is discarded.

Recovered fines are used to bring sand up to specifications. Thousands of tons of valuable sand, formerly lost, soon paid for the low cost of the Whirlcones®.

GIW's highly efficient Whirlcones® are also being used in the mining fields to deslime, degrit, classify, concentrate, make dam and mine backfill and to dewater or thicken where the overflow can be returned to the process or it can be discarded.

They are available in diameters from 6" to 50". Capital cost including the pump is 20 to 50% of conventional classifiers.

If you are losing fines from material −12 mesh to lightest slimes, write today. Recommendations and literature will be forwarded promptly.

COTTRELL ENGINEERING
Division of
GEORGIA IRON WORKS CO.

GIW

Manufacturers of pumps, dredges, separators and accessories.

AUGUSTA • GEORGIA

CONVEYOR SYSTEMS 1600 MI. APART SPEED ORE SHIPMENTS TO U.S.

Specially designed Barber-Greene system utilizing unique hinged arch-type supports mechanizes shipping terminal for U.S. Steel subsidiary

Two Barber-Greene conveyor systems, located 1600 miles apart in South America, help speed manganese ore from a Brazilian mine to a shipping terminal in Uruguay, where the ore is loaded into ships for delivery to U.S. steel mills.

The shipping terminal is operated by Compania Navigen Sucursal Uruguaya, a U.S. Steel subsidiary, and began operation in 1958.

Navigen Company officials say, "The Barber-Greene conveyor equipment at the Transfer Station has operated very satisfactorily and was well chosen." Navigen's Technical Director at Nueva Palmyra during installation reports: "Barber-Greene factory assembled terminals were a great help in erection, particularly due to the scarcity of skilled labor. And we got needed technical and engineering support from Barber-Greene personnel from initial planning through erection and operational stages."

Three conveyors at mine

The mine installation at Corumba, Brazil, operated under contract with another U.S. Steel subsidiary, consists of two tunnel conveyors plus a third barge loading boom conveyor that extends out over the river and is adjustable to river levels and barge heights.

At the shipping terminal at Nueva Palmyra, Uruguay, six Barber-Greene conveyors totalling 2,655' unload barges, stockpile the ore and reclaim it for loading into ocean-going vessels. Stockpiling capacity totals 75,000 tons.

Design features

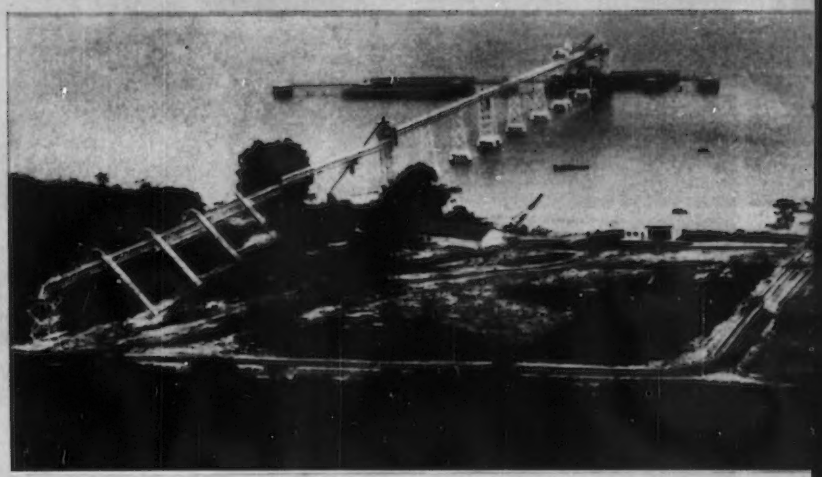
Unique design features: Giant hurricane-proof cantilevered supports that are clear of the stockpile and under which the stockpiling conveyor is hung; reversible belt on the longest conveyor in the system which permits use of the same conveyor for both stockpiling and reclamation operations; run-around system that allows ore to be moved directly from barges to ships when stockpiling is not necessary; and a cantilevered ship loading shuttle conveyor that can be positioned to handle ships of various widths.

The same engineering skill that designed this heavy-duty system to handle 156 lbs./cu. ft. manganese ore is ready to work for you, or your engineering firm. Your Barber-Greene conveyor specialist will gladly explain how standardized or specially engineered systems, or a combination of both, can bring increased efficiency, dependability and lower costs to your material handling problem.

View of inclined conveyor used to reclaim ore from stockpile at Nueva Palmyra. All belts in system are 30" wide and run at average 350 fpm speed. Some of the nearly 1,000 Barber-Greene heavy-duty roller-bearing idlers with 6" diameter rolls are visible here.

Ore from 75,000 ton stockpile is reclaimed by 515' tunnel conveyor fed by 33 gates. Material moves up inclined conveyor, over 854' reversing conveyor and passes over shuttle conveyor enroute to ore boats.

Overall view of terminal shows how whirly crane used to unload barges, hopper, 42" x 10' Barber-Greene belt feeder and tail end of first inclined conveyor are all located hundreds of feet offshore on a cellular dock.



Upper view of 746' stockpiling conveyor at Nueva Palmyra shows top cantiliver supports that resist winds up to 130 mph. Conveyor has traveling tripper that discharges incoming ore onto stockpile.

Send for New Idler Bulletin

New 44-page Idler Bulletin describes the more than 800 units available in the complete Barber-Greene line, tells how their years-ahead features bring longer life and greater economy to every job. Ask for your copy today.

Your belt conveyor equipment headquarters

Representatives in Principal Cities of the World

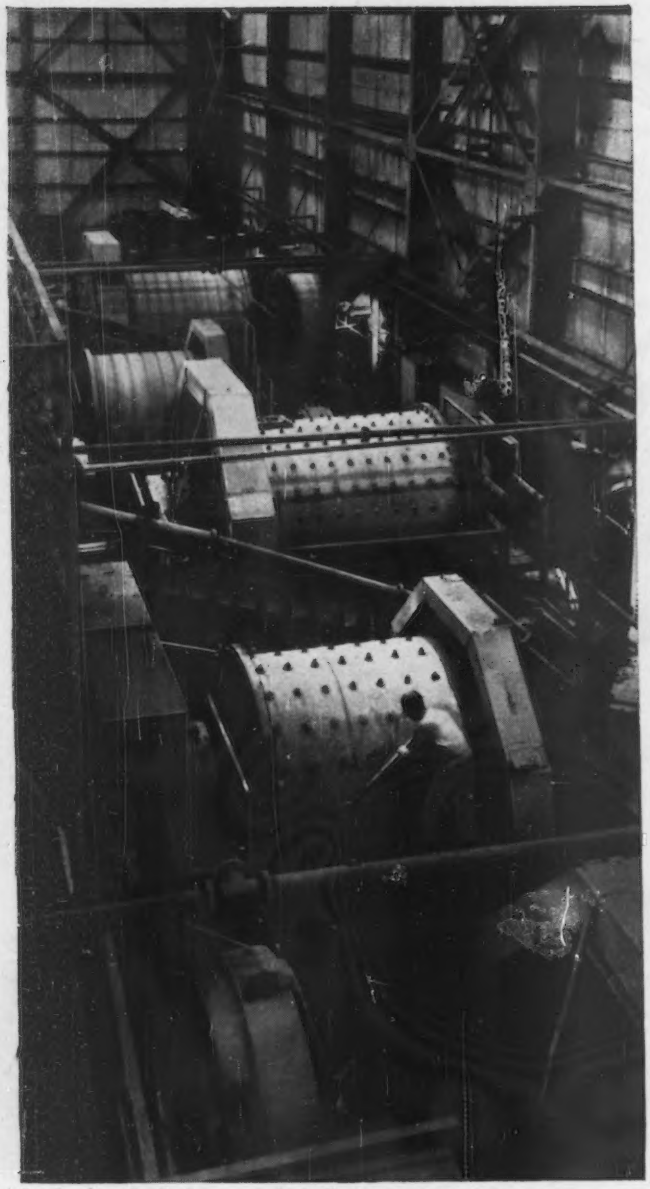
Barber-Greene BG

Main Office and Plant AURORA, ILLINOIS, U. S. A.

Plants in DeKalb, Illinois..Detroit..Canada..England..Brazil..Australia

CONVEYORS • LOADERS • DITCHERS

ASPHALT PAVING EQUIPMENT



On feed end, discharge and shell, Ni-Hard liners have been used in these mills for the past 11 years at the New York Ore Division of Jones & Laughlin Steel Corporation.

Will be good to the last ¼ inch. Note retention of original contour on these Ni-Hard shell liners, in rod mill service. There's plenty of tonnage left in them.

Proof from Jones & Laughlin!

Ni-Hard liners last more than 2½ years, grind more than 2 million tons of iron ore

Here's proof of the long and uniform liner wear you can get with Ni-Hard* nickel-chromium-iron alloy... used here by Jones & Laughlin in both rod and ball mills wet-grinding iron ore.

- Ni-Hard mill liners out-perform cast manganese steel liners by an average of 3½ to 1.
- Ni-Hard liners deliver an average life of 32 months of non-stop, round-the-clock service per set... each set grinding more than 2½ million tons of ore.
- Ni-Hard liners save thousands of *hours* of down-time, and thousands of *dollars* in repair and replacement costs.

If you want to increase your tonnage and lower your costs, try a set of Ni-Hard liners in your mills.

To get the facts on Ni-Hard iron, just call or write your nearby producer of Ni-Hard castings. Or write Inco for the helpful 58-page booklet, "Engineering Properties and Applications of Ni-Hard." A copy will be mailed to you immediately without charge or obligation.

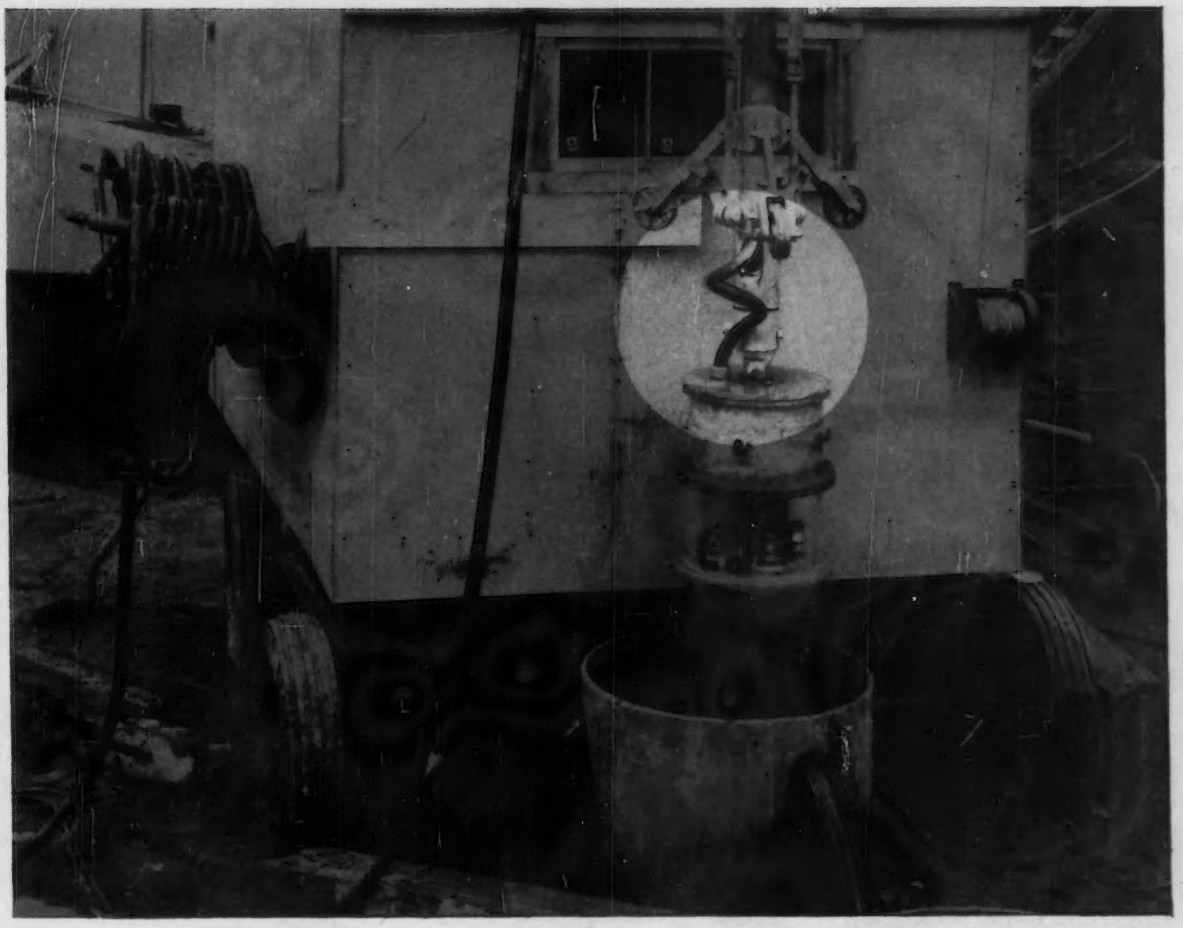
*Reg. Inco trademark

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street INCO New York 5, N. Y.

NI-HARD®

NICKEL MAKES CASTINGS PERFORM BETTER LONGER



OPTIC NERVE FOR EYES THAT SEE 100 FEET BELOW THE SURFACE

This is a television camera. Its job is to photograph the substrata of excavations, thereby providing information needed by engineers in planning the construction of Boston's new Prudential Center, a modern, multi-million dollar real estate development.

Here in the Back Bay section of Boston, with its artificially maintained water table, this sealed camera must go down into a water-filled hole 100 feet below the surface. To transmit the picture from the camera to the surface monitor, Lake Service Corp. of Brighton, Massachusetts, designers and manufacturers of the television equipment, chose Simplex Anhydrex XX insulated cable because of its ability to withstand the rigors of submarine and direct burial duty.

For all types of service involving high and low voltages, whether aerial, underground or submarine, or for everyday plant wiring, it pays to call a Simplex Engineer.

Simplex

BALANCED COMPOUNDING

WIRE & CABLE CO.

Cambridge, Mass. • Newington, N. H.

1885 Diamond Jubilee 1960
75 Years of Leadership in the Wire and Cable Industry

FOR THE FACTS ON GENERAL ELECTRIC'S MOTORIZED WHEEL DRIVE . . .

Ride Lectra Haul on the Mesabi

The minute you climb aboard this latest challenger to the Mesabi's tough operating conditions, you sense the massive power and performance that's at your control.

Powered by General Electric's new Motorized Wheel Drive, Lectra Haul gives you maneuverability and grade-ability never before attained in rear-dump vehicles of its size.

The truck was built by Unit Rig & Equipment Company of Tulsa to satisfy the demand of users for a vehicle that would cut haul costs by combining maneuverability, capacity and performance. Electric drive makes this vehicle possible.

Here's how the new drive works: a traction motor is mounted in the rim of each wheel and bolted to the side of the vehicle . . . completely eliminating the need for axles, transmissions, differentials and drive shafts. Electric power for the Motorized Wheels is supplied by an engine-driven generator.

G-E's Motorized Wheel Drive is available in rim sizes from 29 in. to 45 in.

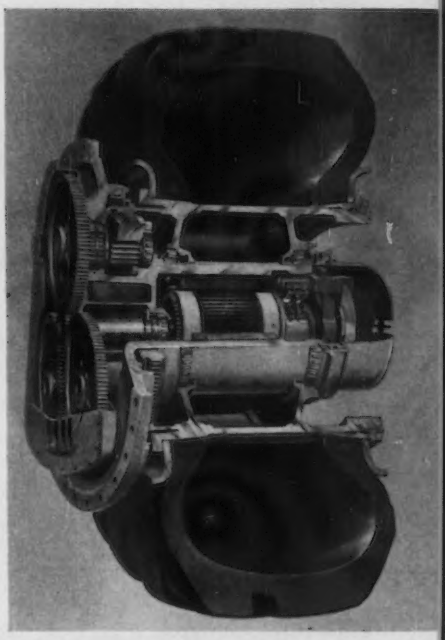
GENERAL ELECTRIC

ALL-WHEEL DRIVE without separate engines, axles, transmissions, differentials, and drive shafts reduces maintenance, increases drive system reliability.

HIGHEST BRAKING CAPACITY without fading or mechanical wear results from dynamic braking allowing safe, high-speed operation.

64-TON CAPACITY with unmatched maneuverability and gradeability allows lowest cost per ton haulage, makes possible profitable mining of deeper pits and leaner ores.

SIMPLE OPERATION provides full control of traction and braking effort at all speeds, unequalled operating ease, safety, and maximum productivity.



PROPORTIONED POWER matches traction conditions at each wheel, providing more working hours under adverse weather conditions and terrain.

INCREASED GRADEABILITY through utilization of engine horsepower at all wheels permits operation over steeper grades at haul road speeds, reduces haul lengths and roadway maintenance.

GREATER MANEUVERABILITY because motorized wheel drive enables Lectra Haul to combine the maneuverability of a king pin steer vehicle with the gradeability of a "weight on drivers," rigid frame vehicle.

FOR COMPLETE INFORMATION on how G-E's Motorized Wheel Drive can help you cut your haul costs, contact your nearby G-E Apparatus Sales Office, or write Section 103-02, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

More proof that...

AMSCO HELPS YOU HANDLE MORE TONS PER DOLLAR

Chuck Weinke, shop superintendent (left) and R. J. Bakken, welder, with Amsco tooth which has just been repointed. Teeth are retipped with repointer bars welded on with Amsco Nicro Mang and hard faced with Amsco #20 electrodes. This combination produces *stronger welds, less cracking* and *longer wear.*

Where equipment works mainly in rock... subject to severe abrasion and shock... Here's the way AMSCO users talk...

"BEST BUCKET AND BACKHOE EVER PUT OUT"

That's operator language from experienced users of Amsco equipment at Ashbach Construction Co., St. Paul, Minnesota. Chuck Weinke, Shop Superintendent... Ray Reichow, foreman, and Elmer Ahlschlager, shovel operator... all agree that Amsco dippers, backhoe buckets *and dipper teeth* are the best they've ever used.

Ashbach does highway, bridge and dam construction throughout the U. S. Much of its work is in rock, so the firm is specially equipped to handle jobs involving severe abrasion and shock. And that's where Amsco shines!

Chuck Weinke, shop superintendent sums it up this way: "The reason we use Amsco products is the long life of the bucket and easier application in welding the teeth. There is so little maintenance in comparison to competitive makes."

Let us give *you* the service life story on Amsco Manganese Steel Dippers, Backhoe Buckets and Dipper Teeth. Contact your Amsco representative, or write us direct for technical bulletins.

*Trade Mark Registered

AMSCO

American Manganese Steel Division • Chicago Heights, Ill.

Other plants in: Denver • Los Angeles • New Castle, Delaware • Oakland, California • St. Louis

Welding products distributed by Canadian Liquid Air Co., Ltd.

AMERICAN Brake Shoe COMPANY

Ashbach Construction Co. shovel, equipped with Amsco Backhoe Bucket, on a road construction job at Fort Snelling, Minnesota. Note rocky terrain.

Russell J. Masters, left, and Elmer Ahlschlager, shovel operator, checking the Amsco teeth on an Amsco Dipper.

Now—more light, less weight, longer life with

NEW EDISON MODEL S ELECTRIC CAP LAMP

MSA announces another new *high* in lighting efficiency in the world's most popular cap lamp. Increased light output of the new Edison Model S Lamp assures greater safety for the miner, more tons per shift for the operator. Let's face a fact: Dimness costs money. *Fair* lighting does only a *fair* job. Maximum lighting—the brilliant, unfailing Edison Model S kind—helps get jobs done with top speed and safety. And the simplified method of charging new Model S Batteries—with the AUTOMATIC LOW-VOLTAGE SYSTEM—is convenient, thrifty and highly efficient. Lets miners take their lamps and rack them—quickly—without loss of time or waste motion. When planning a new lamphouse installation or modernizing your present one, call in the MSA Representative. MSA can help you solve your lighting problems.

Newly issued U.S. Bureau of Mines Approval 6D-31, April 16, 1959.

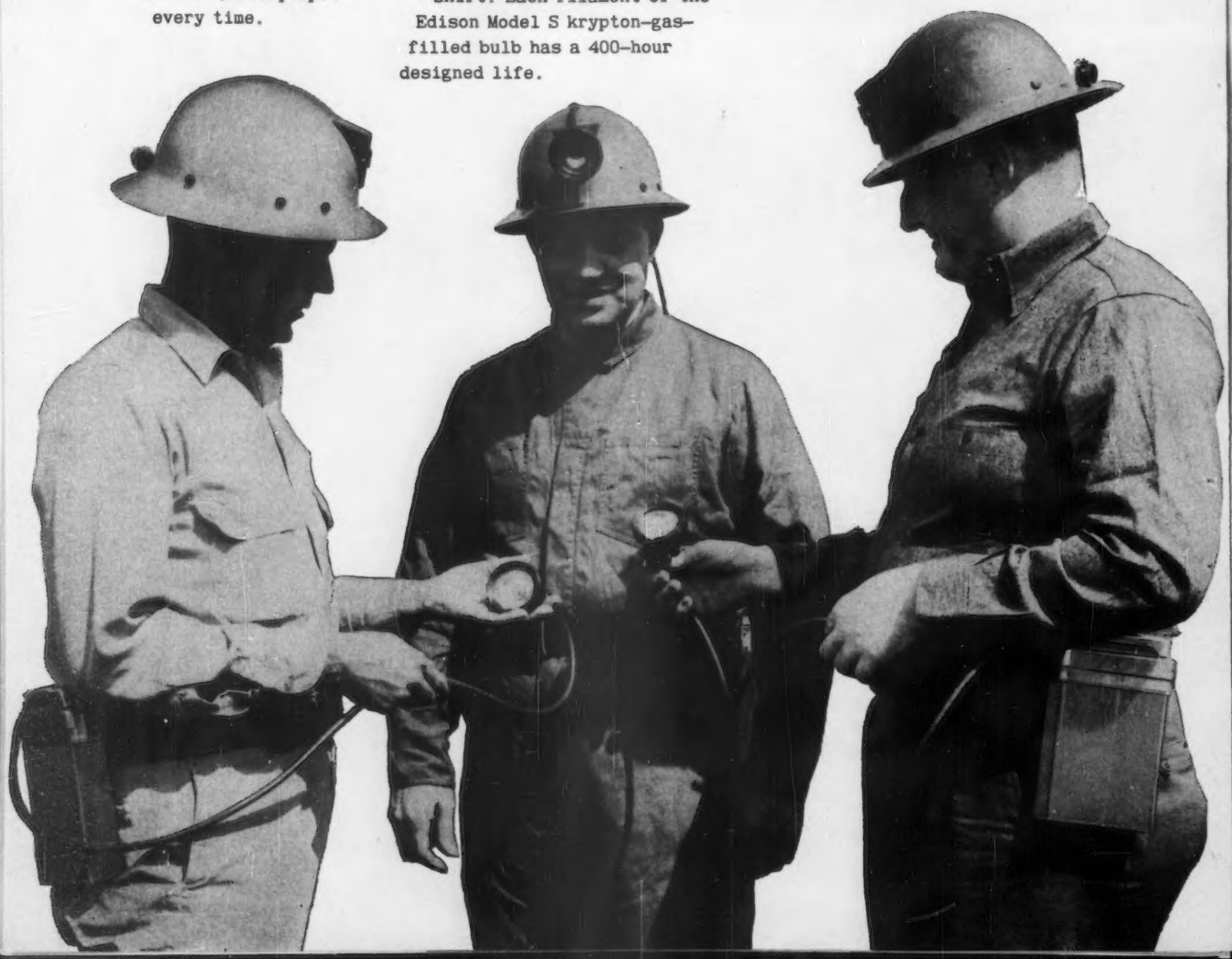
MSA SAFETY EQUIPMENT HEADQUARTERS

MINE SAFETY APPLIANCES COMPANY • 201 North Braddock Avenue, Pittsburgh 8, Pennsylvania
MINE SAFETY APPLIANCES CO. OF CANADA, LIMITED • Toronto, Calgary, Edmonton, Montreal, Sydney, Vancouver, Winnipeg
MINE SAFETY APPLIANCES CO. de MEXICO, S.A. de C.V. • Mexico 4, D.F., Mexico

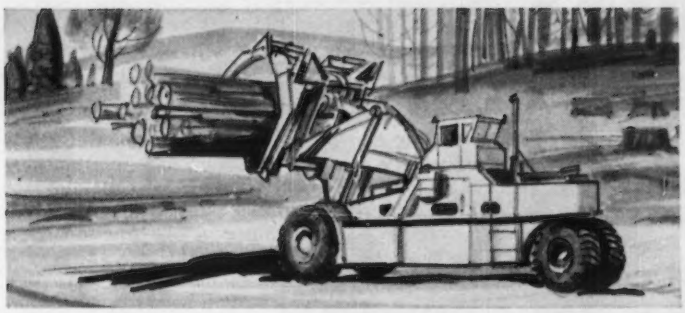
Look how small the headpiece is. Weighs only a few ounces. Feels even lighter on the head. You get a clear, sharp spot every time.

Increase in working light appeals to me. This new Edison Model S gives 15% more than we ever had before. And they didn't cut their bulb service life rating to do it. The double filament bulb means we'll always have working light to finish the shift. Each filament of the Edison Model S krypton-gas-filled bulb has a 400-hour designed life.

Just watch the improvement in our safety and tonnage reports. More light. Less weight. Longer life. Even the battery's better. It has a new active material that boosts service life. They went all-out to meet the miner's needs with this one.

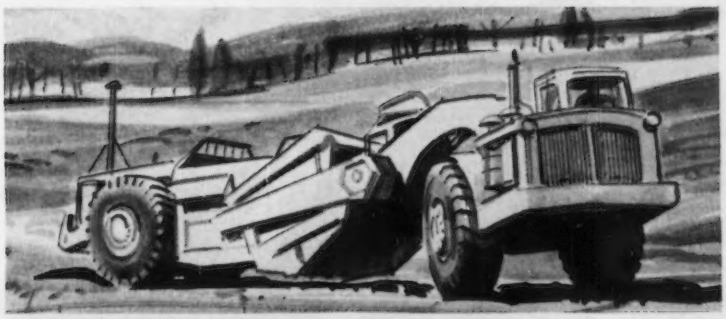


ALLISON
speeds big loads
TORQMATICALLY



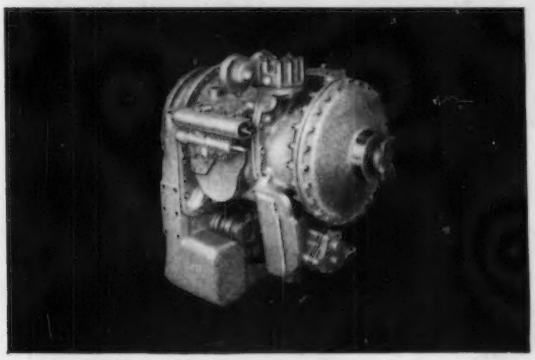
IN "LUMBER JACKS"

Despite a 70,000-lb. lift and carry capacity, the Wagner LJ 3-70 Lumber Jack is designed for fast work in mass-production operations. Its CRT-5630 TORQMATIC DRIVE lets the operator quick-shift at full throttle to speed loads—one reason why it is standard equipment in this machine.



IN TWIN-POWER SCRAPERS

One contractor who owns a Euclid TS-24 Twin-Power scraper reports: "One Twin is equal to five 130-h.p. crawlers with 10-yd. tow-type scrapers." Another says: "One Twin is equal to three 12-yd. self-propelled scrapers plus pusher." Typical? You bet. And the CRT-5630 is one of the TORQMATIC team members that make twin power possible.



IN ANY 200-300 H.P. UNIT

For that scraper, king-size loader or four-wheel prime mover, you'll find faster job cycles and lower maintenance costs with the job-proved CRT-5630 TORQMATIC DRIVE.

It has 3 speeds forward and 3 reverse, planetary direction and range gearing, transfer gearing drop box incorporating front- and rear-output flanges. With six choices of TORQMATIC converters to give that perfect engine match, the CRT-5630 is ideal for a wide range of machines and jobs.

Want more information? Send for the fact-packed CRT-5630 brochure today.

Allison TORQMATIC

TORQMATIC® DRIVES

The world's most complete line of hydraulic drives

Over 980 models used by 108 manufacturers in 100 to 525 H.P. equipment

Allison Divison of General Motors
Dept. MJ-2 Indianapolis, Indiana

Please send me application data on your CRT-5630 TORQMATIC DRIVE.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

JOY-HAZEMAG

IMPACT CRUSHERS

20 MODELS—5 TO 500 TPH CAPACITY

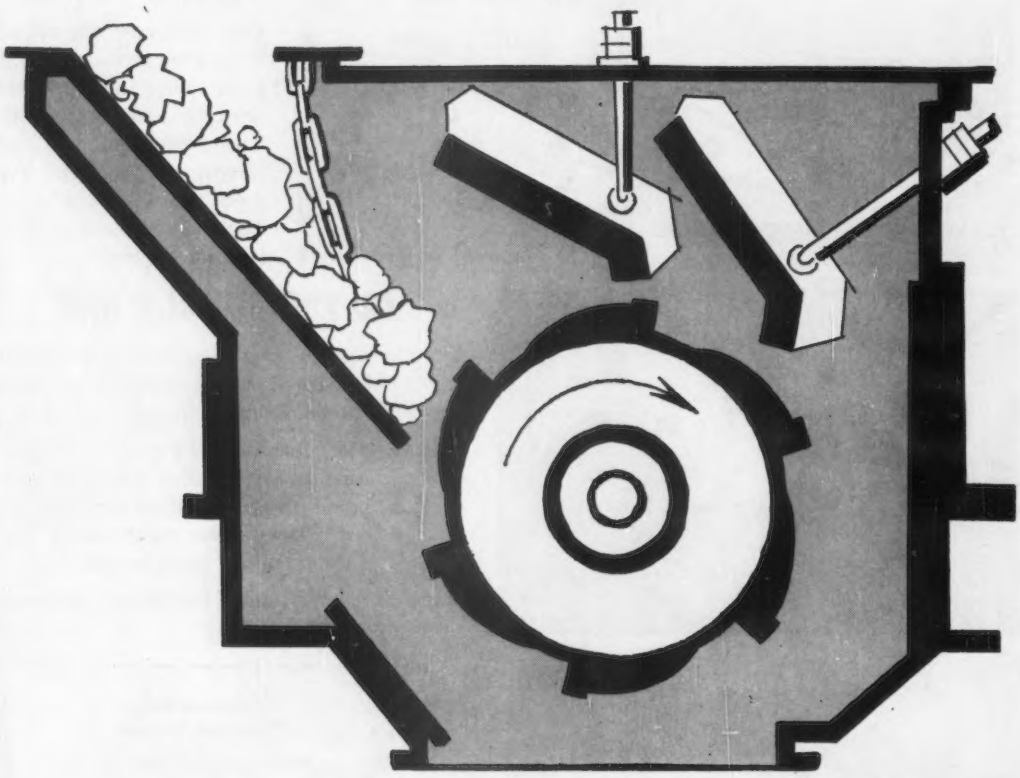
SELECTIVE CRUSHING WITHOUT EXCESSIVE FINES

Iron Ore • Asbestos Ore
Limestone • Coking Coal • Marble
Salt • Gypsum • Slag

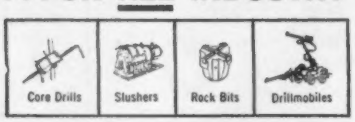
Joy-Hazemag Impact Crushers provide selective crushing of a wide range of materials with efficiency and economy. By adjusting the position of the impact plates and varying the rotor speed, material is crushed in a controlled spectrum of sizes.

Typical Examples: Coking coal can be crushed to greater than 90% through ⅛" while limiting fines (minus 100 mesh) to a minimum; Limestone for fluxing can be crushed to a maximum grade product in a one-pass reduction to minus ⅛" plus 100 mesh; Hard and soft parts of conglomerate can be crushed to different sizes in one pass, for recovery of mineral values in one fraction by a scalping screen.

Write for full information on how Joy-Hazemag Impact Crushers can give you better crushed material at lower cost.



EQUIPMENT FOR MINING . . . FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.
In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

Two reasons why Timken bits give you...

FASTER CHIP

REMOVAL

Chip-clogged bits waste your time and money. You can eliminate this big drilling headache by switching to Timken® threaded carbide insert bits. They clear chips faster because (1) the 5 front hole design, pioneered by the Timken Company, shoots air or water *directly* against the rock face; and (2) the deeper, wider wing clearance enables chips to clear faster. It's a double-action process that lets your drillers cut rock—not chips—for more hole-per-bit.

You save bit dollars another way too. Timken threaded bits have special analysis carbides for better resistance to shock and wear, more reconditioning life. And bit bodies are made from Timken fine alloy steel for added strength.

No wonder more miners drill with Timken bits than any other removable bit. They get these money-saving advantages plus on-the-spot service from Timken Company field engineers. It's the kind of service you can't get anywhere else. For more hole-per-bit on *your* drifters, sinkers and stopers, use Timken threaded bits. They're available in a complete range of sizes and types. For more details, send for our free brochure, "Timken Removable Rock Bits". The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

FOR OTHER TOUGH DRILLING JOBS

ALL-STEEL MULTI-USE

This improved Timken bit gives lowest cost per foot-of-hole when you can drill out full increments of steel.

TAPERED SOCKET BIT

Taper gives the strength of one-piece steels. You get the same chip-removal features as threaded bit shown above.

TIMKEN®
removable rock bits

Conveyors at their Best!

Carrying hot calcined gypsum is the tough job of special Hewitt-Robins belts at the Shoals, Indiana, plant of U.S. Gypsum. In service since 1955, these 24" Maltese Cross butyl hot materials handling belts twist at the end pulleys, allowing the bottom cover to become the top cover, and vice versa, every other trip. This adds years to belt life.

H-R belting also:

- Provides exceptional longitudinal strength and cross-wise flexibility.
- Starts smoothly, even on "across-the-line", fully loaded belt start-ups, due to controlled, low belt elongation.

The engineering and top quality you'll find in Hewitt-Robins conveyor systems and belts are built into all H-R equipment. For full details consult your H-R representative, or write Hewitt-Robins, Stamford, Connecticut. Ask for Bulletin **12-16.**

HR HEWITT-ROBINS

THE NAME THAT MEANS EVERYTHING IN BULK MATERIALS HANDLING SYSTEMS . . .

CONVEYOR BELTING AND IDLERS • INDUSTRIAL HOSE • VIBRATING FEEDERS, SCREENS & SHAKEOUTS • POWER TRANSMISSION EQUIPMENT

DENVER

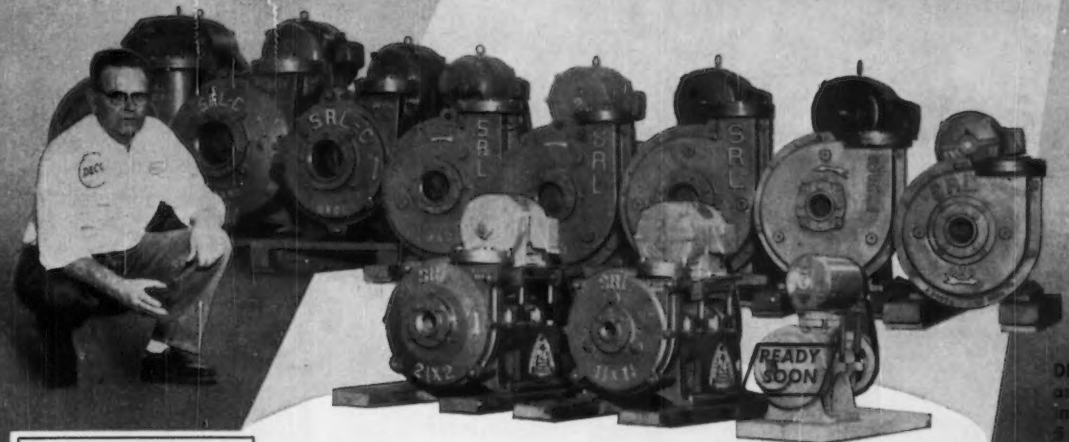
3 NEW PUMPS!

New, small DENVER SRL Pumps offer high efficiency* in low volume pumping jobs.

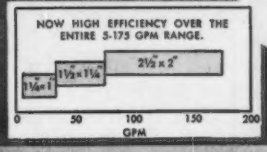
* In the past, many operators with small volume pumping problems have been forced to use larger pumps which were actually oversize for the job and were inefficient. This has resulted in reduced part life by as much as 300% and wasted horsepower in addition to less-than-expected pump performance.

These 3 new DENVER Pumps are designed specifically to offer increased pumping efficiencies in the low gpm range.

2½"x2" for 75 to 175 GPM range
1½"x1¼" for 35 to 75 GPM range
1¼"x1" for 5 to 35 GPM range



2½" x 2" 1½" x 1¼" 1¼" x 1"



DENVER SRL Pumps are now available in capacities from 5 to 3500 GPM. In stock for quick delivery.

"The firm that makes its friends happier, healthier and wealthier"

DECO ENGINEERING STANDARD RELIABLE 24 HOUR SERVICE EFFICIENT

DENVER EQUIPMENT COMPANY

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- **LONDON** 13-17 Christopher St. Finsbury Square Phone Bishopsgate 3575
- **JOHANNESBURG** 9th Ave. and Broadway Bez Valley Phone 25-7531
- **TORONTO** 185 Bay Street Phone EMpire 3-8836
- **VANCOUVER** 802 Credit Foncier Bldg. Phone MUtual 3-7595
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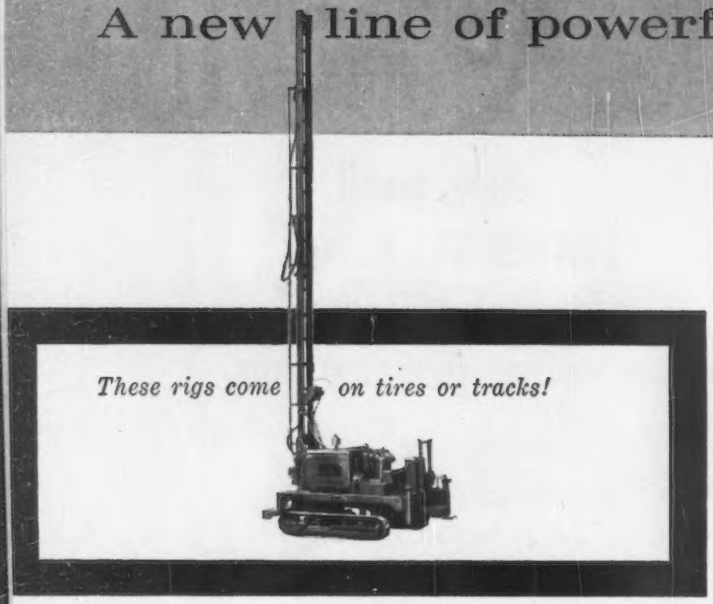
ANNOUNCING LE ROI'S

A new line of powerful . . . highly portable . .



THE LRD-2

Here's a highly portable blasthole drill for making hole up to 4½ inches as deep as 30 feet . . . equipped for either positive-drive rotary drilling or powerful down-the-hole percussive drilling.

What's more, the LRD-2 is completely self-contained . . . and economically priced, too!

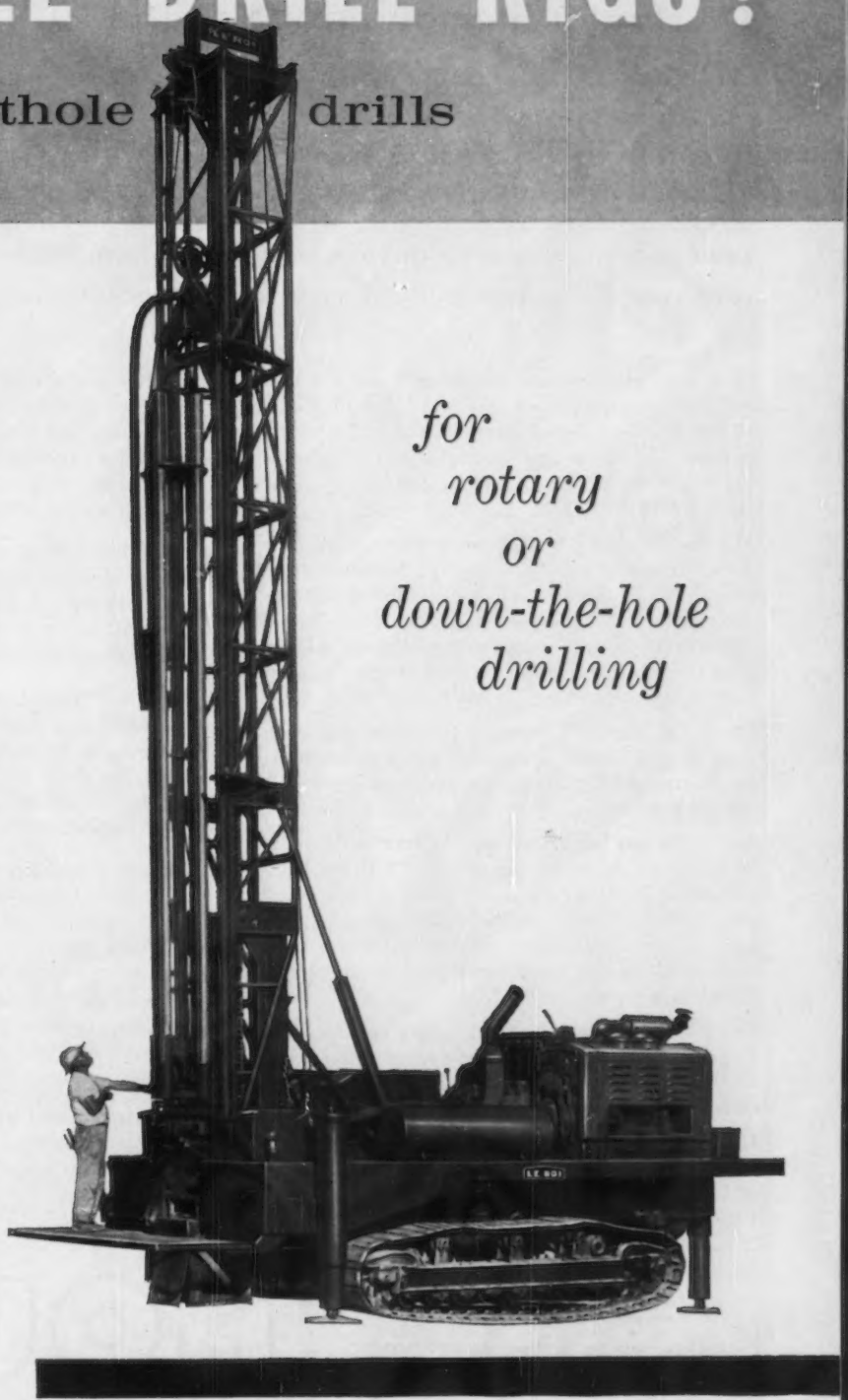
The entire unit is easily handled by one man. Controls are conveniently grouped at an operator's station located alongside the drilling area. The unit can be moved, leveling jacks hydraulically set, boom hydraulically raised, drill pipe and bits connected, and hole started — all with a few non-fatiguing motions.

Powerful direct mechanical drive keeps the rotary table turning — won't bog down or lose torque under rough going like air or hydraulic driven units — eats through tough rock formations under 10,000 lbs. pulldown pressure at speeds from 40 to 250 rpm. If necessary, a hard-hitting down-the-hole drill can quickly be substituted for the rotary bit to drill extremely hard rock formations. A Le Roi 25 hp two-stage air compressor provides ample air for powering the down-the-hole drill and cleaning out hole . . . or is available in single-stage where only rotary drilling is necessary.

The self-propelled LRD-2 is available either on crawler or tire mounting and with either gasoline or diesel power unit. A whole list of extra equipment is available to ease or speed drilling, including lights for night-time operation, a mounted bit grinder, air hoist, breakout tongs, water injection system, etc. . . . all detailed in Specification Sheet AT-146. Write for your copy.

DEEPHOLE DRILL RIGS!

rotary blasthole drills



for rotary or down-the-hole drilling

THE LRD-3

Here's the *big* rig . . . completely self-contained for putting down hole as large as 7⅞ in. to 100 ft. depth!

The LRD-3 is available with either crawler or truck mounting. An enclosed cab can be furnished to provide all-weather protection for the operator while drilling. All controls are conveniently grouped for easy operation and good visibility.

The traveling head design of the LRD-3 provides positive mechanical power without excessive torque loss under heavy pulldown, and permits easy control in making up and breaking down drill-rod. Every function of the unit is designed to speed productive drilling and keep the operator making hole. Leveling, raising the mast, and even the automatic drill pipe magazine are hydraulically controlled for speedy operation. A powerful dust collector traps cuttings and blows them well away from the unit.

An extra-sturdy 4-speed chain-hydraulic pulldown puts up to 30,000 lbs. of pressure on the bit of the LRD-3. A rugged dual-range transmission provides rotary speeds from 9 to 168 rpm in a selection of 10 forward and 2 reverse speeds.

Where needed, the rotary bit can be quickly changed for a powerful down-the-hole drill. A Le Roi 100 hp dual-manifold air compressor provides plenty of 100 psi air for punching through tough rock with the down-the-hole drill, or it can be set to deliver 625 cfm of 40 psi air for fast, efficient removal of cuttings in rotary operation.

The LRD-3 comes complete with a hydraulically operated magazine with capacity for four 20 ft. drill pipes, and can be equipped with optional convenience equipment similar to the LRD-2. Specification Sheet AT-147 describes the unit in detail, with complete spec information. Send for a copy.

LE ROI

division of Westinghouse Air Brake Co.

Sidney, Ohio

On-the-job performance of the Model H-120 proves it far more

productive

because it has more power, better balance, longer reach and more dumping height than any tractor-shovel in its class

Productive capacity and performance are the true measures of any machine, and the 4¼-yard Model H-120 excels on both counts. Hough's greater experience and "know how" in tractor-shovel engineering was never more apparent than in the design of this big PAYLOADER.

The Model H-120 has 300 horsepower – more than any other machine in this category. Maximum tractive and hydraulics demands are handled simultaneously without "lugging down." The H-120 has a higher horsepower-to-weight ratio – as much as 30% more than other machines in its size range – because a lot of useless dead weight has been eliminated.

The H-120 has more dumping clearance, and more dumping reach, than comparable units. It loads big trucks and railroad cars more evenly and easier – can stockpile higher.

The H-120 has better balance and stability because of the exclusive use of extra-strong "T-1" steel for box section boom arms that saves over a ton of dead weight on the load-carrying end. The approved and exclusive use of dry ballast material in the rear tires lowers the center of gravity with 50% of the weight below the rear axle.

The H-120 has a separate oil-cooling radiator that is fan-cooled. This exclusive feature provides effective cooling of the transmission-torque converter oil even in hot climates.

The H-120 is even easier to drive than smaller tractor-shovels, say the operators, because of power air-brakes, power-steer, power-shift, and unusual visibility.

The H-120 has a distinctive boom design, forward and clear of the operator for greater safety. It features a single bucket-tilting ram and high-leverage linkage with a tremendous breakout force. Another big advantage is simplicity and fewer parts, reducing wear and maintenance.

The H-120 has a Hough-built full power-shift transmission of advanced design. It is a full reversing, constant-mesh type providing 4 gear ratios in each direction. All four gear changes are made with one lever and *without stopping* for a "range" shift.

The H-120 has "Operators-Choice" brake control — exclusive in its class. Dual pedals permit the operator to brake with or without the transmission engaged, as desired for any operating situation. The large-capacity 4-wheel air brakes contribute greatly to the easy, safe handling of the machine.

The H-120 has special protection throughout to promote long life and reduce maintenance of the engine, drive train and hydraulic systems. A special dry-type, two-step, engine air cleaner gives 99.8% dust-removal efficiency under the most adverse conditions. The hydraulic system is sealed and pressure-controlled to keep out air-borne dirt, and also protected by an exclusive system of cartridge-type filter and fine mesh screens.

The H-120 is provided with canopy-type cab, windshield wipers and special lights as standard equipment. Bucket sizes are available from 3¾ to 8 cu. yd. (S.A.E. rated). The exclusive 4 cu. yd. Drott 4-in-1 bucket can also be supplied.

THE FRANK G. HOUGH CO.
726 Sunnyside Ave., Libertyville, Ill.

Send full data on big Model H-120 PAYLOADER.

Name_____

Title_____

Company_____

Street_____

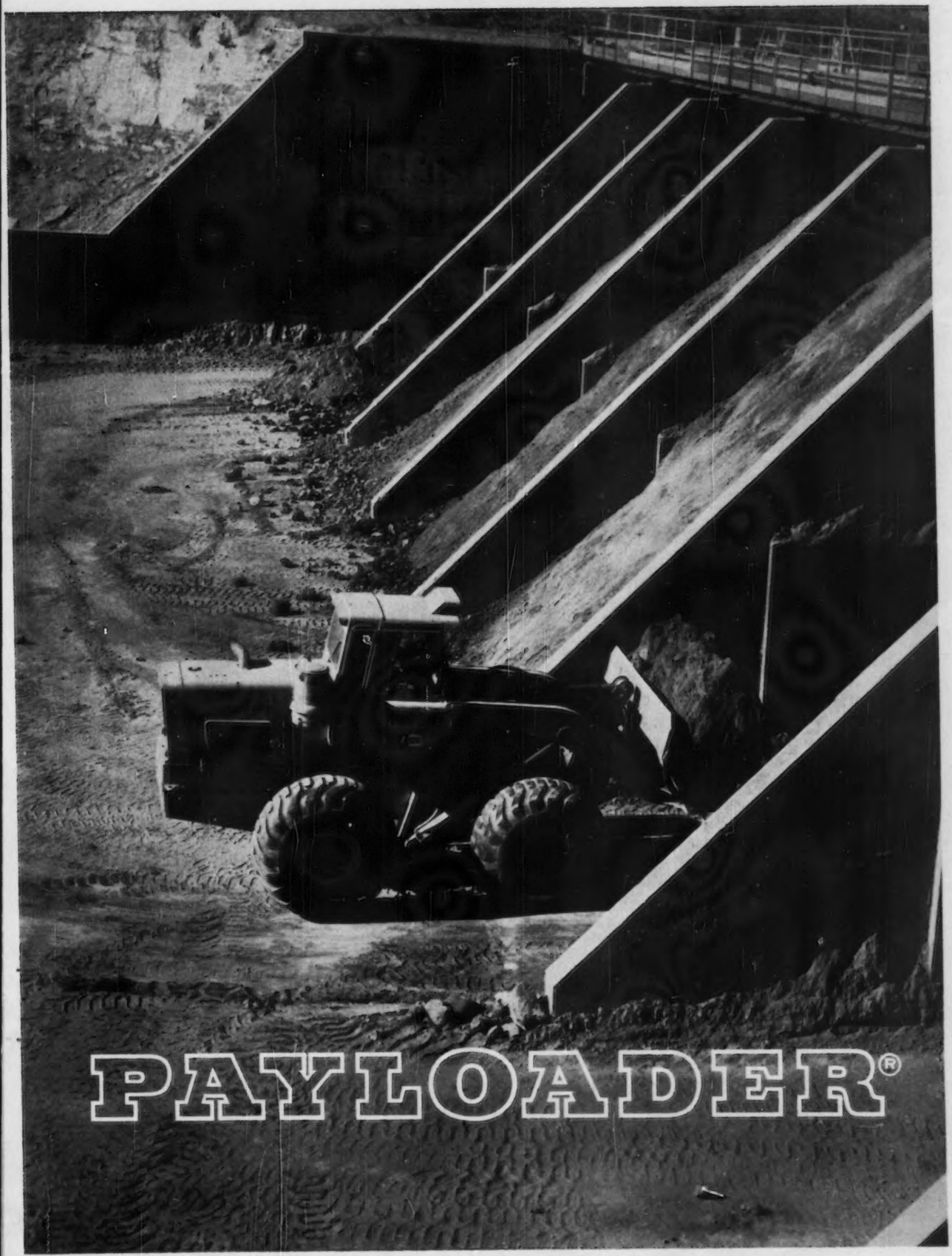
City_____ State_____

12-B-4

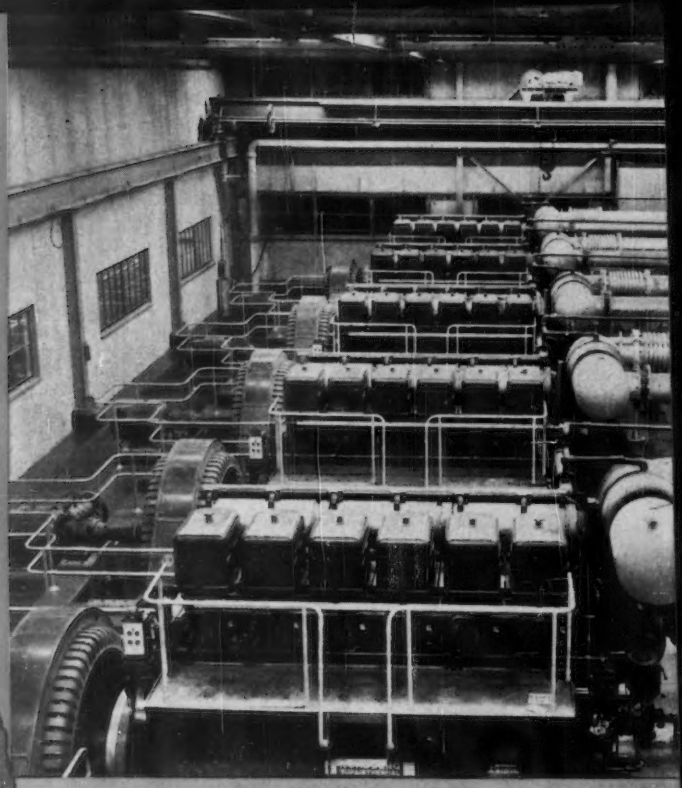
HOUGH®

THE FRANK G. HOUGH CO.
LIBERTYVILLE, ILLINOIS
SUBSIDIARY – INTERNATIONAL HARVESTER COMPANY

HOUGH, PAYLOADER, PAYMOVER, PAYLOGGER, PAYLOMATIC and PAY are registered trademark names of The Frank G. Hough Co.


PAYLOADER®

HOW NORDBERG MACHINERY SERVES THE MINING INDUSTRY

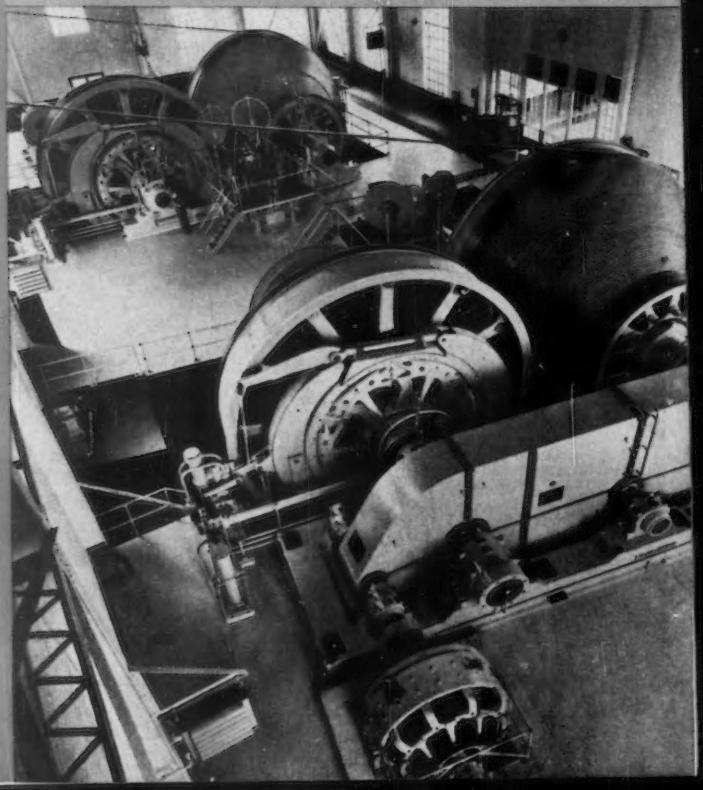


IN POWER GENERATION

Nordberg engines are built in sizes ranging from small power units to over 12,000 horsepower in a single engine . . . and are available for Diesel, Duafuel® and Spark-Ignition Gas operation.

IN HOISTING

Nordberg has an established reputation second to none, and can furnish both conventional and friction type mine hoists for men and material, to meet specific requirements.



NORDBERG MFG. CO.
Milwaukee 1, Wisconsin

SYMONS SCREENS NORDBERG

SYMONS . . . A Registered Nordberg Trademark Known Throughout the World.

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MINNEAPOLIS • NEW ORLEANS • NEW YORK • ST. LOUIS • SAN FRANCISCO
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LONDON • MEXICO, D. F.

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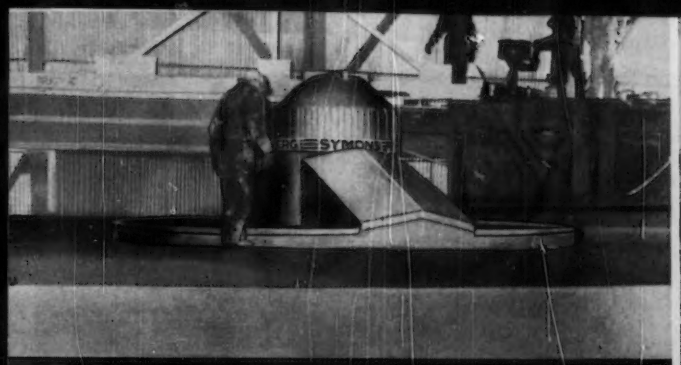
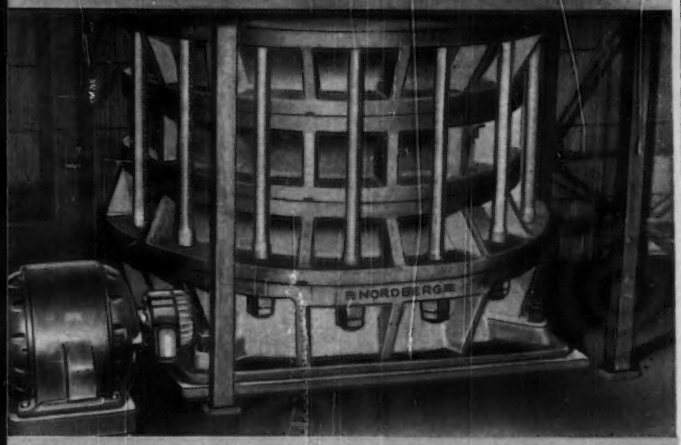
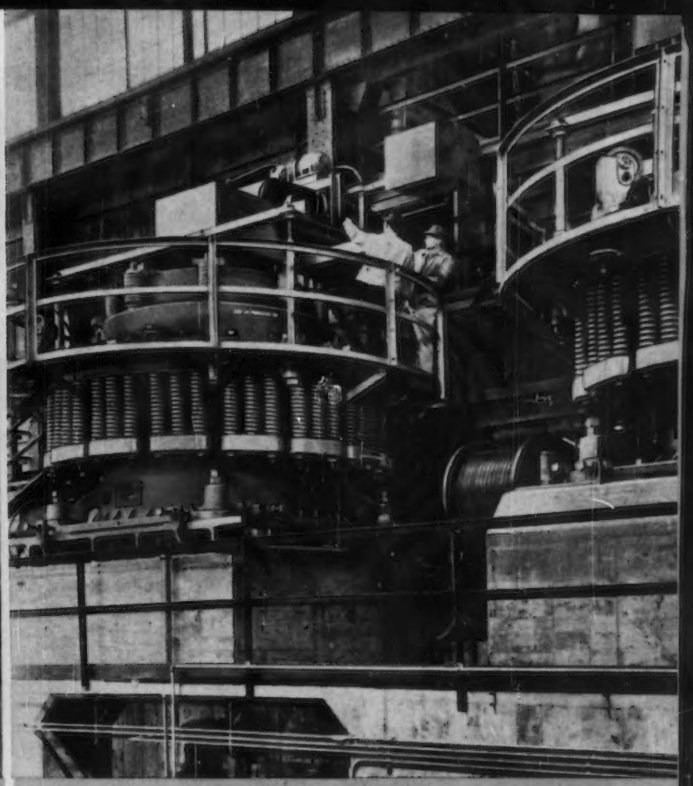
EM169







IN PRIMARY CRUSHING

Symons® Primary Gyratory Crushers are built for big tonnage, heavy duty primary breaking in 30″, 42″, 48″, 54″, 60″ and 72″ feed opening sizes. Capacities to 3500 or more tons per hour.

IN FINE REDUCTION CRUSHING

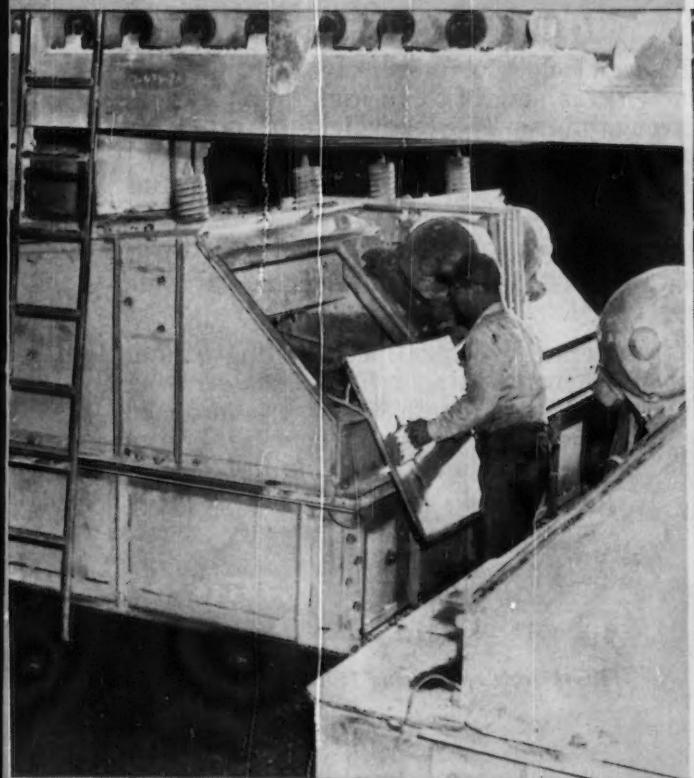
Symons Cone Crushers, the machines that revolutionized crushing practice, are built in both Standard and Short Head types, in sizes from 22″ to 7′ in diameter. Capacities from 6 to 900 or more tons per hour.

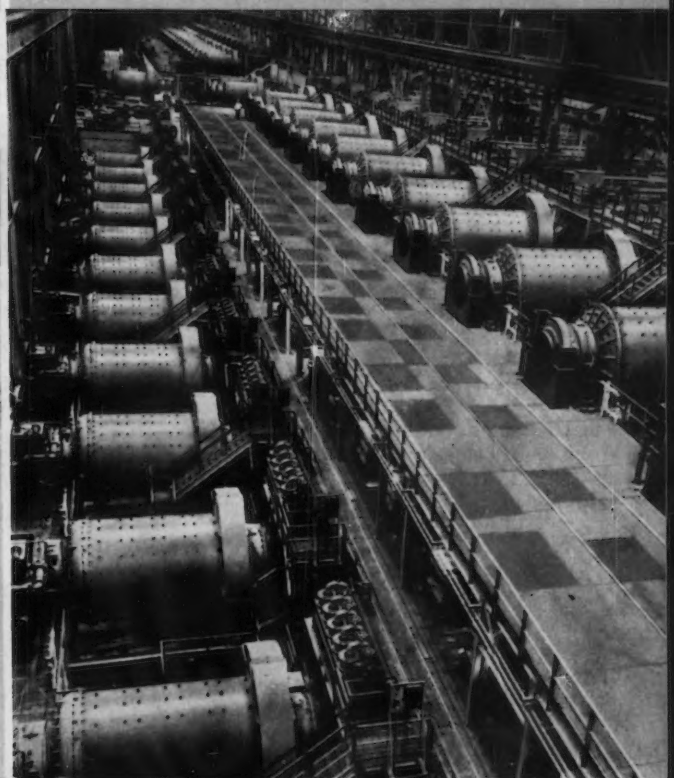
IN SCREENING

From scalping to fine screening, there is a Symons Screen built to do a better job at low cost. Let Nordberg experience help you select the screen best suited to your needs.

IN WET AND DRY GRINDING

Nordberg Grinding Mills include Rod, Ball, Pebble, Tube and Compartment types, in sizes from 6′ to 13′ in diameter and up to 50′ in length.





The Mining Machines You'll

YESTERDAY, Marion rail-mounted steamers were the marvel of their era, taking back-breaking labor out of loading and helping giant industries move toward big production.

Here are the machines that will set new pit standards in the decade ahead . . . machines that will help write new chapters of progress in world mining history. And, they will do it through the simple expedient of providing owners with features that 1. cut costs, 2. reduce maintenance, and 3. increase profits. Here are just a few of those features.

1. Dipper capacity up from 8 to 9 cubic yards on the 181-M; from 10 to 11 cubic yards on the 191-M.

2. New crawler design incorporating greater clearance between side frames and crawler lugs; doubled strength in larger, hardened roller pins and shafts; manganese bronze bushings for extended operating life.

You get **MORE** *with* **MARION**

Need in the 1960's

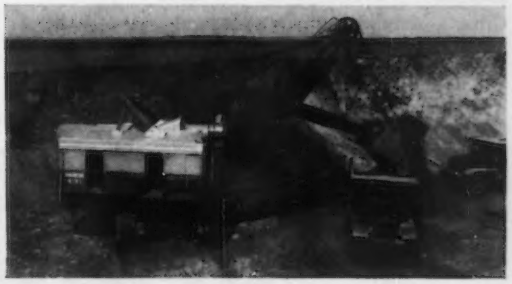
3. Operator's cab on the 181-M extended to the side for greatest possible visibility.

4. Induction hardening of important gears to cut maintenance costs.

5. Heavier top plate, reinforced lower frame for maximum rigidity under toughest working conditions.

6. New concepts in excavator control which will make the present Marion outstanding control system even better.

These plus many other important design features will help owners of these units explore new horizons of high profit excavating in the 1960's.



TODAY, the daily output of Marion 4161 and 151-M machines in the open pit mines sets industry standards for costs. Dependable Marions will continue to mine a big percentage of the world's ore for years to come.

MARION POWER SHOVEL CO. — MARION, OHIO

A Division of Universal Marion Corporation

MOLY ALLOYS MEAN LONGER LIFE WHERE YOU NEED IT MOST

In the mine, in the pit, in the quarry . . . the payoff is at the point of hardest wear. Specify long life molybdenum-containing alloys in your equipment and you immediately cut down the number of shutdowns for part replacement, and increase productivity without boosting capital investment.

You can satisfy just about every high wear rate application with one of the four grades developed by Climax . . .

For gouging abrasion plus impact, **use 12-2 alloy.**

For grinding abrasion, **use chrome-moly steels.**

For scratching abrasion and erosion, **use 15-3 alloy.**

For general purpose abrasion resistance, **depend on 3-2-1 alloy.**

All four have been proved in years of actual mining use. Make sure your equipment benefits by these advanced materials.

Complete details are in "The Role of Molybdenum In Abrasion Resistant Materials", available on letterhead request. Climax Molybdenum Company, 1270 Ave. of Americas, New York 20, N. Y.

CLIMAX MOLYBDENUM

CLIMAX MOLYBDENUM COMPANY
a division of AMERICAN METAL CLIMAX, INC.

For carloads or small lots

Nineteen convenient smelters and refineries

ASARCO

ASARCO: Buyer, smelter, refiner of gold, silver, lead, copper and zinc ores and blister copper, concentrates, mattes and residues. Fifteen domestic and four Mexican plants located for maximum accessibility as follows:

LEAD SMELTERS
Selby, California
Leadville, Colorado
East Helena, Montana
El Paso, Texas
Chihuahua, Chih., Mexico

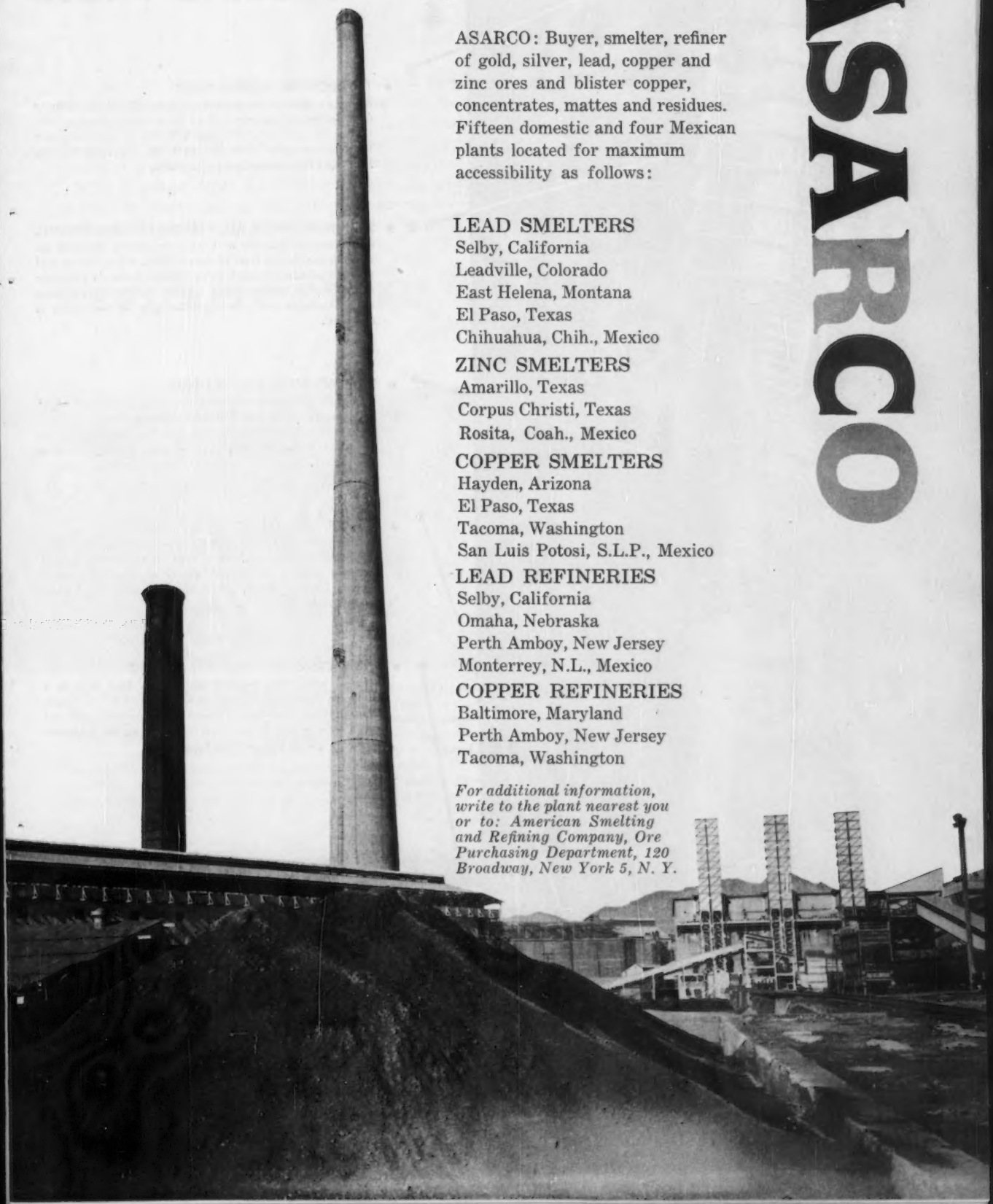
ZINC SMELTERS
Amarillo, Texas
Corpus Christi, Texas
Rosita, Coah., Mexico

COPPER SMELTERS
Hayden, Arizona
El Paso, Texas
Tacoma, Washington
San Luis Potosi, S.L.P., Mexico

LEAD REFINERIES
Selby, California
Omaha, Nebraska
Perth Amboy, New Jersey
Monterrey, N.L., Mexico

COPPER REFINERIES
Baltimore, Maryland
Perth Amboy, New Jersey
Tacoma, Washington

For additional information, write to the plant nearest you or to: American Smelting and Refining Company, Ore Purchasing Department, 120 Broadway, New York 5, N. Y.



MISSING THESE

- **1. PRECISION-TAPERED PLUG**
  Expertly engineered for proper shell expansion. Angle of taper is at the precise degree required for strength, dependability, and quick efficient tightening. Whether in relatively soft formations or other types of rock strata, improved Republic Mine Roof Bolts assure best performance.

- **2. HIGH-STRENGTH, ALL-PURPOSE EXPANSION SHELL**
  New, improved Republic RS-1 Expansion Shell is designed for effective use in any type of strata. Wide, strong leaves and flaring inside taper mean extra holding power in relatively soft formations. Narrow base supports for the leaves assure easy expansion and a wedged-like grip as the anchor is tightened.

- **3. HEAVY-DUTY SUPPORT NUT**
  Square nut gives over 40% better support than even the best previous method, yet maintains correct bolt tension by stripping at approximately 50 pounds torque with no damage to bolt threads. Nut can be easily applied either side up—another plus feature.

- **4. IMPROVED SELF-CENTERING HEAD**
  Compact, one-piece head eliminates need for separate washer. The heavy flange and thick, reinforced washer are guided cleanly and firmly into position in the bolt plate. Entire unit is forged, for ruggedness and strength. Standard 1⅛″ head available with ¾″ and ⅝″ bolt sizes.

- **5. MATERIAL CONTROL CERTIFICATE**
  Included with every shipment of Republic Roof Bolts is a certificate stating specific physical properties of the steel used. Data provided: yield point in pounds per square inch, yield and break point in pounds, and steel heat number. No guesswork about the quality you get from Republic.

MINE ROOF BOLT MATERIAL CONTROL CERTIFICATE

Republic Steel Corporation hereby certifies that the mine roof bolts included in mill order number _____ were made from the following steel:

HEAT NO.	YIELD POINT (PSI)	YIELD POINT (POUNDS)	BREAK POINT (POUNDS)

The above figures are correct as contained in the official records of the Corporation.

BY _____
CHIEF METALLURGIST, BOLT AND NUT DIVISION

REPUBLIC STEEL CORPORATION
General Offices • Cleveland 1, Ohio

FIVE CERTIFIED-PERFORMANCE FEATURES?

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There are, in Quebec, 27 major stone quarries. 25 of them do their stockpile loading with Michigan Tractor Shovels.

The amazing record for one machine at one pit:

416 TRUCKS LOADED IN 8 HOURS

Production like this certainly *helps* explain the popularity of Michigan Tractor Shovels.

But there are other reasons for this popularity—reasons which *might be of great importance in YOUR profit picture*. As a case in point, let's take ownership in Quebec, Canada.

In Quebec, over 90% of all the major rock quarries use Michigan Tractor Shovels for stockpile loading! This overwhelming preference, this record of buying and rebuying at this location, we feel, is particularly significant. For in Quebec, machines are tested by terrific extremes of *working* temperatures—40° *below* to 110° above. Tonnage demands are increasing rapidly. Distances are great and job sites are often hundreds of miles from service facilities.

Model 275A bucket-loads average 4.50 yds, 5.85 tons each, per scale-measurement.

Repeat buyer likes Michigan dependability, dealer service

One typical Quebec owner—LaGace Quarries Ltd, Montreal—exemplifies the reasons for Michigan popularity under these conditions. "Michigans usually load faster than other Tractor Shovels," says Paul LaGace. "Hence they produce more. Michigans cause less trouble, mechanically speaking. And when something does go wrong, we get excellent service from our Michigan Distributor (Blackwood-Hodge Ltd) and from Clark."

The LaGace firm reports from long experience. They bought one of the first Michigan Tractor Shovels sold in Canada—a 1¼ yd Model 75A—in 1954: Today, they own six Michigans: the original Model 75A, two Model 175A's equipped with 2¾ yd buckets, and three Model 275A's equipped with 4½ yd buckets.

20 seconds per bucket load

Loading with *any* of these units from *any* of 22 crushed stone stockpiles—4" and run of crusher to lime dust—takes an average of only 20 to 25 seconds per pass, according to company time-study averages. Thus, a skilled operator and a 4½ yd Model 275A regularly heap a 25 ton hauler in five passes, under 2 minutes. A 12 ton tandem-axle truck takes a 275A two passes, 40 to 50 seconds. Top daily load count, so far, for a Model 275A has been an amazing 416 trucks, 10 to 15 tons each, in 8 hours! Production, overall, with the six Michigans loading at LaGace's two pits, has averaged 1,000 to 2,000 tons hourly—over three times as much as before Michigans.

Other jobs: loading shot rock, cleanup after blasting, etc.

The Michigans do a lot of odd jobs too. In emergencies, they have loaded quarry rock. Several of the units often handle cleanup after blasting, dozing and lifting material into high, centrally-located shovel-efficient piles. At times, they clean spillage from haul roads and crusher sites. They tow stalled vehicles. In winter, they plow snow. As Raoul Savage, quarry supt, puts it, "*Whenever we want to lift or haul anything, we just call for one of the Michigans.*"

Michigan is a registered trademark of

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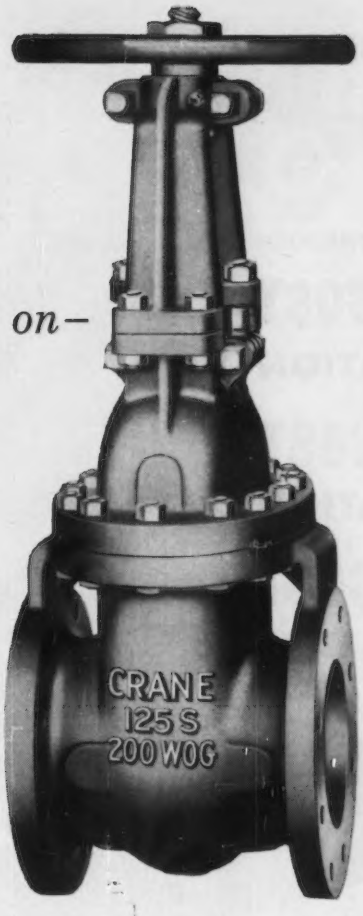

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125-pound iron body
gate, bronze trimmed.
Sizes 2" to 48".

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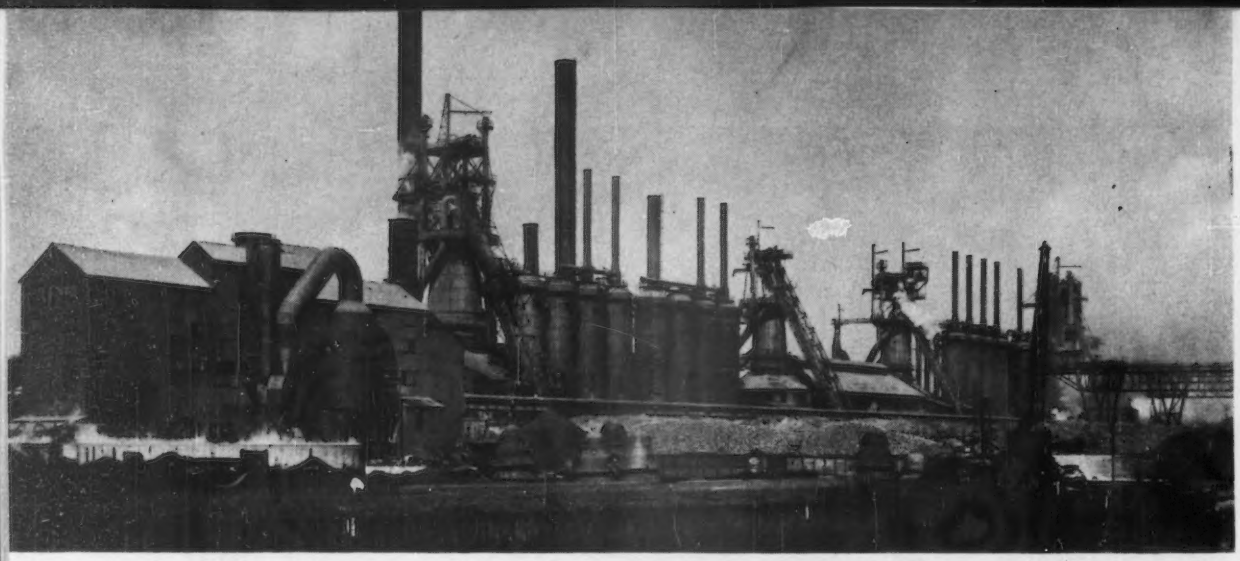


THE CHAMP—Iron blast furnaces, like the four here with their attendant stoves, have long dominated ironmaking picture. They're efficient and reliable; yet millions of research dollars have been spent to find ways to reduce iron without them.

SPECIAL REPORT

Iron—How Is Direct Reduction

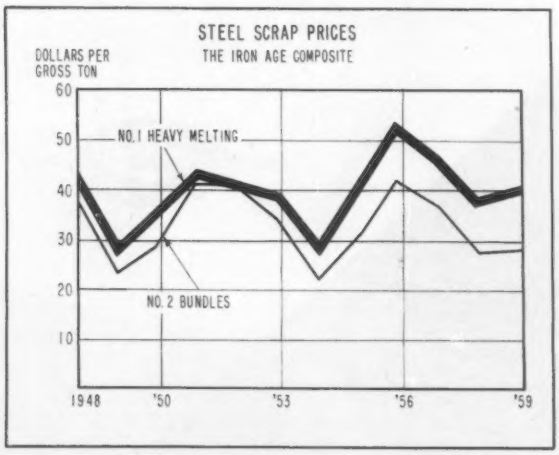
Much interest and publicity has attended recent attempts to get around the blast furnace — long-time ironmaking king. Here's a look at how the newcomers have progressed and where they seem headed.

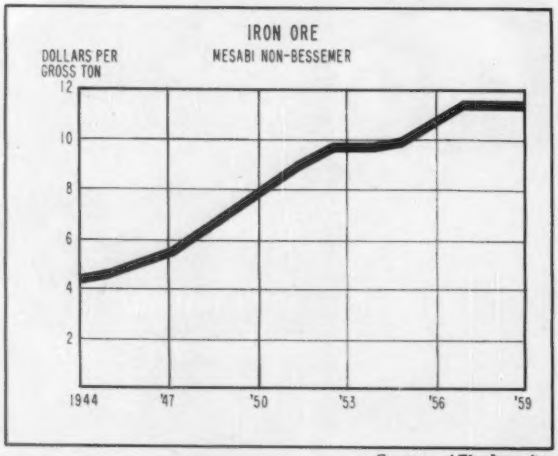
COLIN C. McANENY

ONE OF THE MOST PROGRESSIVE INDUSTRIES in the minerals field over the last decade has been iron and steel. Iron and steel men have spent many millions of dollars in research, trying to make their products more cheaply, and trying to make new and better products. Dollars-and-cents necessity has spurred these efforts.

"Direct reduction" of iron ores has accounted for a hefty share of the steel research dollar, and has also generated much thought, work, and publicity. E&MJ thinks it is opportune to look again at direct reduction, as it did in December 1957, to ask why it has aroused so much interest, to see how far it has come and where it seems to be going.

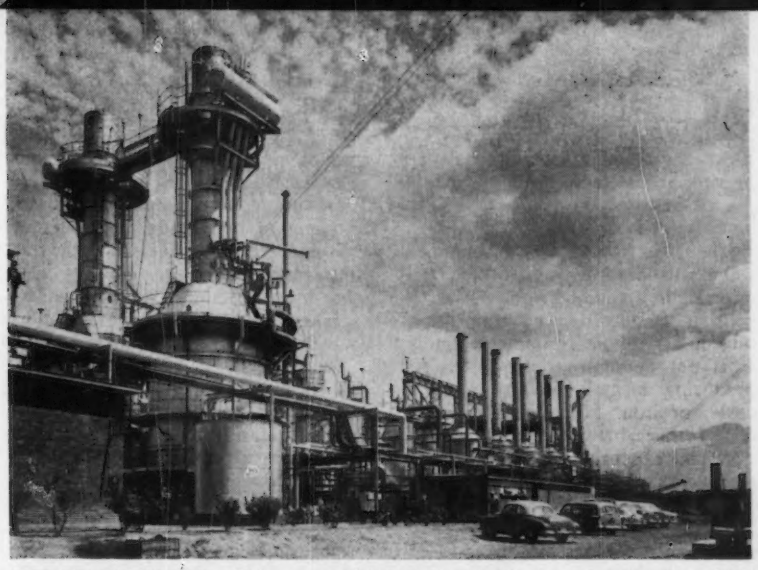
The spur in the iron industry's side





Courtesy of The Iron Age.

STEELMAKERS, foundrymen must wrestle with fluctuations of scrap market, left. Contrast steadier price of ore, right. Desire for steadier price, better control of tramp elements, is incentive to develop direct iron processes.



THE CHALLENGERS—This commercial HyL plant in Mexico, operating since 1958, shows iron can be made successfully in other ways where local conditions are right.

Doing Commercially?

has been rising costs and diminishing reserves — a classical example of forces leading to change. The blast furnace, one of the key tools of the iron and steelmaker, has been getting more expensive to build. Coking coal —high-grade coal which can be made into metallurgical coke — is getting scarcer and more expensive; and metallurgical coke is the only fuel that the blast furnace can use. Thus, the blast furnace's capital cost and operating cost have both been moving up.

One of industry's reactions to this cost trend has been to investigate direct reduction, which simply means, in contrast to the blast furnace, an alternative way to make metallic iron from iron ores.

A look at the price of steel scrap (graph, p. 84) will show another reason for the steel man's interest in direct reduction. It has been described as "wildly gyrating." Certainly scrap has been anything but steadily available or steadily priced. Steelmen use scrap as a large part of the charge to their steel furnaces; and foundrymen melt it for part of their casting stock. The unsteady price of scrap, and also the uncertainty of its composition because of all the alloying elements that may have gone into it, are both headaches to the steelman and foundryman. Direct reduction might serve as a "headache powder" if it could produce iron that would suitably substitute for scrap, and, very importantly, if it could do it cheaply enough that the steelman or foundryman could afford it.

To properly understand what direct reduction is trying to do, let's take a brief look at the manufacture of iron and steel.

The essential steps in the production of steel are reduction, smelting, and refining, followed of course by the various metalworking operations of casting, rolling, annealing and many others to give the final desired product in the desired form. Practically entirely, today, reduction and smelting are carried out in the blast furnace. It receives cold, solid iron oxide, and discharges a hot, molten product known as pig iron when cooled and cast, or simply as "hot metal" while still molten. The step of refining is carried out in a number of processes, the most important of which, tonnagewise, at the present day is the open-hearth furnace, though also important are the older Bessemer process, the new and increasingly important L-D oxygen converter process and the electric furnace. Product of the refining step is steel, usually cast into ingots for further metal-working treatment.

This simplified description of steelmaking is included only to show the background into which direct reduction processes fit. Where, then, does direct reduction fit in? As the name itself says, in the reduction step; and certain D-R processes carry out the smelting step as well. The bailiwick of direct reduction, therefore, is the bailiwick of the blast furnace. Although the two systems differ widely in many implications, so as to prompt some authorities to say they are not really competitors; nevertheless, they both do the same job. Hence they must be understood in relation to one another.

Some sixty years ago, Dr. Henry Marion Howe wrote of the blast furnace, "The process is economical because it utilizes, with extraordinary completeness, the calorific power of coke due to the thorough transfer of heat from the gaseous products of combustion to the charge." His enthusiasm was well founded. The blast furnace is an excellent metallurgical tool. It is reliable and efficient; it turns out huge quantities of iron from almost all grades and types of ore. It is definitely the only important large-scale process for making iron today. In the opinion of many experts, it will maintain its pre-eminent position for as long as can be foreseen.

Yet, in almost any given month, the technical literature will contain some article on direct reduction. Last April, the AIME Metallurgical Society heard five papers dealing with direct reduction; some 18 papers on the subject were presented at the May meeting of the Electrochemical Society.

If the blast furnace is so eminently good, why then all the interest in a substitute for it?

Blast Furnace Is Big-League

The $6,000 automobile may be quiet, comfortable, luxurious and desirable to own, but it did cost a lot more than the owner can or would like to pay. Chances are, when he leaves the gas pump, the owner is anything but smiles as he puts his billfold away. For all its advantages, the blast furnace, too, has features that must be counted as liabilities.

For one thing, the blast furnace is very expensive to build. Not only is the furnace itself a large, intricate structure, but it demands large, costly auxiliary equipment, such as the ovens for making metallurgical coke and the stoves for heating the blast air. Owen R. Rice, of Koppers Co., addressing the Electrochemical Society, pointed out that between 1950 and 1958 the average daily production of all U.S. blast furnaces rose from 849 to 1,066 net tons of pig iron, and that in 1958, 35% of them were 25 ft or over in hearth diameter, compared to 23% in 1950. In short, the economic break-even size of a blast furnace is growing larger. Larger furnaces, of course, mean more expensive furnaces.

A blast furnace plant, including coke ovens, to produce 1,000 net tpd of pig iron, would likely cost in the neighborhood of $40-million, in the eastern U.S.

Just as the $6,000 auto burns super-premium gas, so the blast furnace absolutely requires metallurgical coke. The key features of metallurgical coke are its composition—it must be free, within specified limits, of sulphur, phosphorus and ash—and its physical size and strength. It must be large-sized enough, usually no less than 1-in. lumps, to form a permeable bed within the furnace so that the blast gases can readily pass through. It must be strong enough to support the weight of the charge above it in the furnace shaft, and to resist abrasion as it passes down through the furnace. Metallurgical coke comes only from high-grade coking coals. The U.S. has huge reserves of lower-grade coals, but those of the good coking coals are limited, and as these are used, the delivered price of the coking coals will almost inevitably rise.

The blast furnace is economical when run continuously at high tonnages, but it is not flexible. It is expensive to start up and shut down; thus it cannot be run intermittently. It is not an appropriate device for producing a small quantity, continuously, of iron. Moreover, relining a blast furnace between campaigns is a slow and expensive job. For the several weeks of downtime that this requires, the furnace's capacity is not available.

There are obvious incentives to develop a method of ironmaking other than the blast furnace.

There are companies who could make and market or use iron on a smaller-than-blast-furnace scale, given an economical process. All of them are not in a position to buy a plant as expensive as a blast furnace plant. There are countries which lack the resources of high-grade coal that the U.S. and others are blessed with, but which have iron ore deposits and other forms of energy and reductants, such as natural gas, oil, lower-grade coals and hydroelectric power.

There are users of special grades and forms of iron: high-purity iron powder, for instance. Powder metallurgy is a fast-growing field, because for many involved shapes it is cheaper and easier to fill a mold with powder and sinter this into solid shape than it is to cast molten metal. There are scrap-users who would welcome a more consistent source of iron, both price- and quality-wise.

Let's look at the direct reduction processes, then, and see which ones have got their commercial feet wet.

Some Processes Are Producing

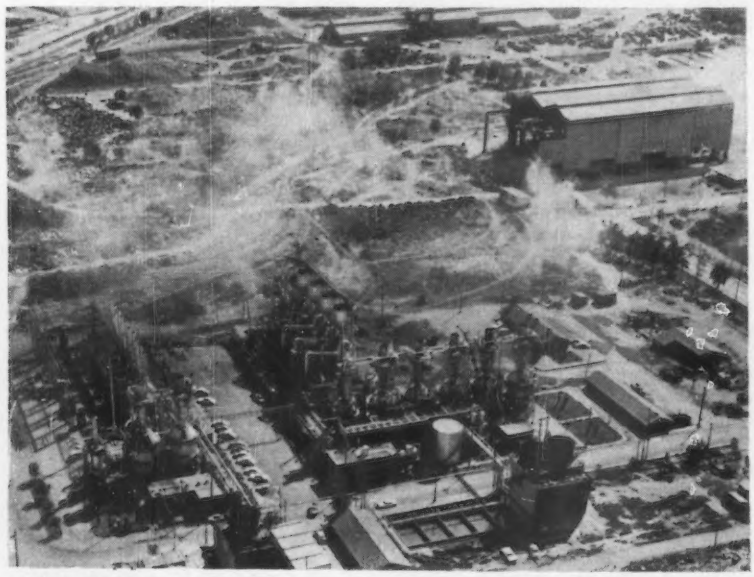
The HyL Process

This and the next five processes are definitely in the commercial arena now.

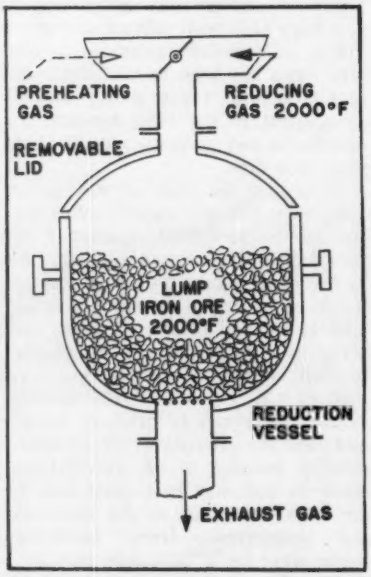
As we go to press, HyL is the leading commercial direct reduction process on the North American continent. It has operated successfully since March 1958, when Hojalata y Lamina. S.A., which is a leading Mexican steel producer, started up its 200-tpd plant in Monterrey, Mexico. An established electric-furnace plant, the Monterrey works used scrap exclusively as feed. The HyL process was designed to produce sponge iron to substitute for some of the scrap.

Because the 200-tpd plant has been an economic success, the company has had a new 500-tpd plant built adjacent to it. The new plant was started up last month. M. W. Kellogg Co. of New York, which built both plants, has long experience in building refineries and gas plants. Thus, they were originally called in by HyL Co. engineers to design the gas re-forming equipment for their pilot plant.

Also, Kellogg and Premium Iron Ores Ltd. of Canada, are negotiating the building of an HyL plant at Fort William—Port Arthur, Canada, on L. Superior (E&MJ October 1959). With a capacity of about 450-tpd,



COMMERCIAL IRON PLANT, Mexican style. New 500-tpd HyL plant (center), older 200-tpd plant (left), feed electric steel furnaces (upper right) at Monterrey.

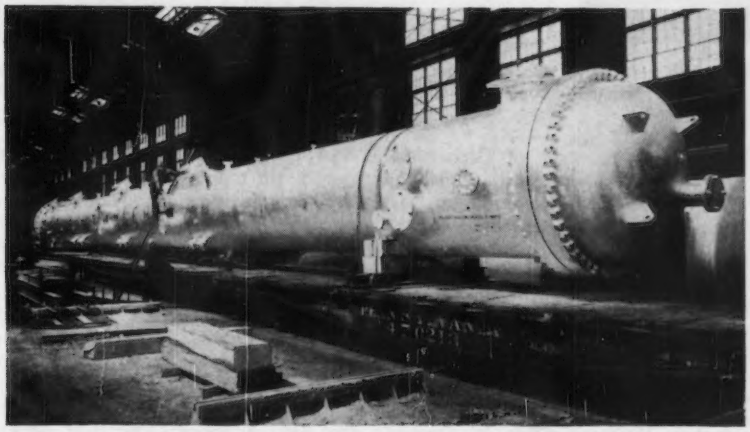


In HyL reactor, preheating and reducing gases pass through fixed charge bed.

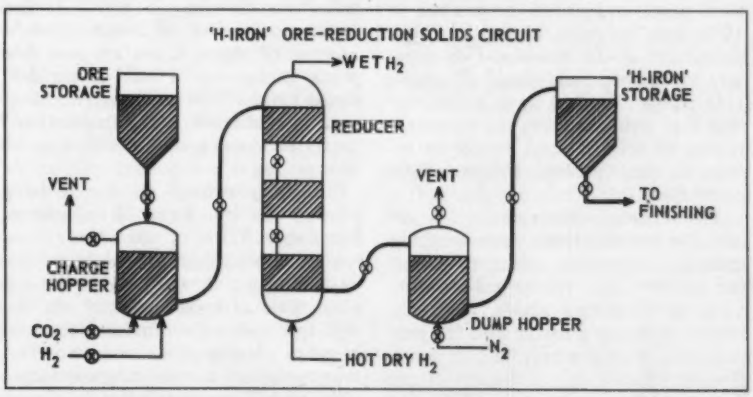
this plant would process Steep Rock Lake ores with Alberta natural gas.

The Process—HyL uses a fixed-bed reactor through which gases may be blown. To preheat the charge to reaction temperatures (about 2000°F), hot oxidized gases are first blown through it. Schematic sketch, bottom of p 86, shows principle of HyL reactor. Reductant is a hot mixture of hydrogen and carbon monoxide, produced by catalytic steam reforming of natural gas. (See p 98 for discussion of different ways of making reductant gas mixtures.) Rich lump ore, sinter, or pellets, of minus 1½ in. size, are charged. About 20% minus-¼-in. can be tolerated; too many fines block the gas flow. It is a batch process. In the 200-tpd plant each of five reactors produces a 15-ton mass of sponge iron; then the charge from the reactor is dumped into a hopper which is moved to an electric furnace, where the sponge is charged hot. Details of the new 500-tpd plant have not been published, but according to Kellogg, several improvements have been made, including a system of using the hot sponge to preheat the natural gas, the sponge itself being cooled in heat-exchange fashion, rather than charging the hot sponge directly to the furnace. This step also serves to carburize the sponge, a desirable step for furnace operation.

CHEMICAL ENGINEERING, Dec. 28, 1959, gave a detailed description of the 200-tpd HyL plant.



HEART of Bethlehem's new H-Iron plant, at Los Angeles, is 3-bed fluidizing reactor, here shown being shipped. Vertically mounted unit is 122 ft 6 in. in height.



FLOW OF SOLIDS through H-Iron plant is shown here. Reductant, hydrogen, is generated externally, flows upward through three fluidized beds in reducer.

The H-Iron Process

This is another D-R process that has actually gone into commercial operation on the North American continent. Alan Wood Steel Co. has operated a 50-tpd H-Iron plant at its Conshohocken, Pa., works since April 1959. This plant was built for the special purpose of producing fine low-carbon iron powder for sale in the expanding powder-metallurgy market. Numerous papers and technical articles have appeared on the Alan Wood plant (e.g. CHEMICAL ENGINEERING, Feb. 8, 1960).

The second operating H-Iron plant has been built at the Vernon works of Bethlehem Pacific Coast Steel Corp. in Los Angeles, and is now being started up. It is expected that technical details will be published in the next few months. The plant is designed for 110 tpd capacity, and the reduced iron will be charged as melting stock to electric steelmaking furnaces.

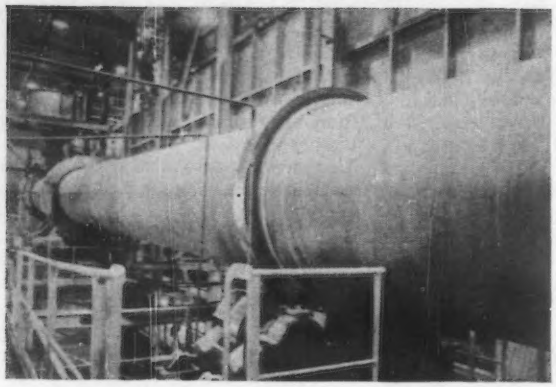
The Process—Reaction vessel is a 3-stage fluidized-bed reactor. Iron oxide is progressively reduced by hot hydrogen, which is generated by the Texaco-HRI partial oxidation process (see p 98). The ore must be high-grade and sulphur- and phosphorus-free. In the Alan Wood plant magnetite concentrates assaying 71% Fe, and steel plant millscale, are charged, in sizes of about 20-200 mesh and 80-325 mesh respectively.

The process is a combination of batch and continuous. It is continuous with respect to reductant gas, which circulates through the reactor at all times. But it is batch with respect to solids — when reduction in the third (lowest) reaction bed is substantially complete, material in this bed is removed to the finishing stage. Material in the second bed is then transferred to the third, material in the first bed to the second, and fresh feed is placed in the first bed.

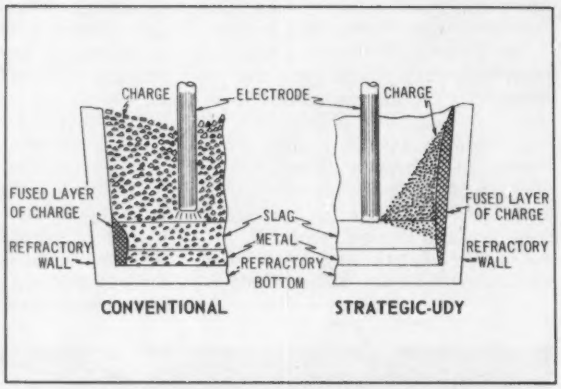
H-Iron is one of the lowest-temperature D-R processes; reaction temperature is about 1000°F. It is by far the highest-pressure process; reactor pressure is about 500 psig, and charge-hopper pressure (before the first stage) is about 650 psig. Solids are transferred through the system by "dense-phase transport," i.e. as a gas-solid slurry under high pressure, through 1½" pipes.

It is necessary to use a "finishing" stage, to heat the iron to 1500-1600°F, and then cool it, all under an inert nitrogen atmosphere, to passivate it, or render it nonpyrophoric. Pyrophoricity means spontaneous ignition on exposure to air, and is a problem that has long plagued sponge-iron processes.

H-Iron is jointly owned by Bethlehem and Hydrocarbon Research Inc., of New York. It grew originally from a 20-tpd plant that HRI operated at Brownsville, Texas, in 1948, to produce iron catalyst to be used in oil refinery applications.



STRATEGIC-UDY process pre-reduces ores in kiln, left, then smelts pre-reduced ore, copper slag, etc. in electric furnace.



Open-arc method of furnace operation distinguishes process, in contrast to conventional submerged-arc practice.

The Strategic-Udy Process

Although there is no commercial plant using this process at this time, it is so close to commercial development that it will soon be in the ring.

Universal Cyclops Steel Co. of Ridgeville, Pa., is financing a new Strategic-Udy plant, comprising a 10,000-kva electric furnace and a 150x 11-ft rotary kiln, at the Strategic Materials Corp. semicommercial pilot plant at Niagara Falls, Ont. Steelwork was due to be complete at about E&MJ press time, and the plant should be onstream in early spring.

Zeckendorf Steel Co., a unit of Webb & Knapp, Inc., of New York, in October signed a contract with the Bonneville Power Administration for power for a S-U plant at Anaconda, Mont., which will produce steel from the slag pile and current slag production of the Anaconda Co. copper smelter. At the very favorable rate of about 2 mills per kwh, power delivery will start in July 1963. Koppers Co. will begin plant construction next spring. The 40-million-ton slag pile will be processed at the rate of 2,000 tpd, and 1,000 tpd of current hot slag will be used. Sales contracts for the finished steel have been signed with customers in the northwest U.S. and western Canada. Freight rates, negotiated with western railroads, will be published this month. The Anaconda mill will have finishing facilities for steel reinforcing bars, which will find a ready market in large dam construction due soon on the Columbia River.

A similar S-U steel mill at Clarkdale, Ariz., has been announced by Zeckendorf Steel. So far, acceptable power rates have not become available, but Zeckendorf claims to be ready to start the project if suitable rates can be negotiated with Arizona Public Service Co.

The Government of Venezuela, which owns a steel mill with nine 36,000-kva Elkem electric furnaces, plans to team one of these with a 250x11-ft S-U kiln, and to install rolling mills, tube mills, and other finishing facilities. Two Canadian S-U projects have been announced: one for a 150,000-tpy plant at Kingston, Ont., by New Mylamaque Explorations Ltd., to treat ores from an iron property near Newboro, Ont.; one for a plant at Varennes, Que., by Quebec South Shore Steel Co. Both these developments await financing.

Koppers Co., a leading builder of steel plant equipment, contracted in 1958 with Strategic Materials Corp., developers of the Strategic-Udy process, to engineer and build Strategic-Udy plants. The two have announced that they will guarantee the economic results of their process, based on results at the Strategic Niagara Falls pilot plant.

The Process—Strategic-Udy is essentially an electric-furnace smelting technique, operating differently from the conventional submerged-arc furnace, as illustrated above. With the electric furnace, a rotary kiln for prereduction of oxides may be (but is not always) associated. Off-gases from the electric furnace are used to fire the prereduction kiln. A variety of forms of solid carbon reductant, including coke breeze (fines from blast-furnace coke production), anthracite fines, and char (partially burned low-grade coal) may be used in the rotary kiln. Ore may be charged in sizes from minus ⅜ in. down to fines. Ores can be treated with wide variations in iron and in titanium, silica, sulphur and other impurities, and manganiferous ores can be smelted to yield ferromanganese and pig iron. Naturally as in any process, the better the ore, the cheaper it will be to get the final product. Except for the batch nature of tapping the furnace, the S-U process is essentially a continuous one. Finished product from the first electric furnace is molten pig iron (hot metal), and if another furnace is used in line, refined molten steel can be produced.

The Wiberg-Söderfors Process

This is a "classical" direct reduction process, invented by Prof. Martin Wiberg of the Royal Technological Institute, Stockholm, in 1918 and first installed in a commercial plant at Söderfors, Sweden, in 1932. It has been commercial in Sweden for a number of years. There are now five plants there, with a total of six furnaces, (in addition to the original furnace in Söderfors) with an estimated yearly production of 150,000 tons of sponge iron.

Licensing control of the Wiberg process is by Stora Kopparbergs Bergslags A/B, of Sweden. Stora has announced that Hitachi Metal Industries in Japan will build a Wiberg plant with an initial capacity of 10,000 tpy and with provision for expansion. Negotiations for another Japanese plant are in progress. However, no Wiberg installation has been made or planned in North America.

Because the Wiberg process has been well established for some time, it has been described at length in metallurgical texts. Bray's "Ferrous Production Metallurgy" (John Wiley & Sons, N.Y., 1954) gives a good description.

The Process—Wiberg furnace is a shaft furnace into which cold or preheated lump ore or pellets are charged to the top and from which hot sponge iron is discharged at the bottom. Final reduction, near the bottom, is carried out by hot reducing gas, mainly car-

bon monoxide, which is generated in an auxiliary carburetor charged with coke and heated by electric arcs from carbon electrodes. About three-quarters of the gas is recycled to the carburetor, being withdrawn roughly half way up the furnace. The rest of the gas passes up through the furnace: it first prereduces the lower part of the ore, then is burned with air introduced near the furnace top to preheat the fresh ore.

The Wiberg furnace utilizes very efficiently the calorific and reducing powers of the coke. It is not a small installation, however, and furthermore the ore must be fairly large-sized, somewhat as in the blast furnace, so that the gases can pass upward through it.

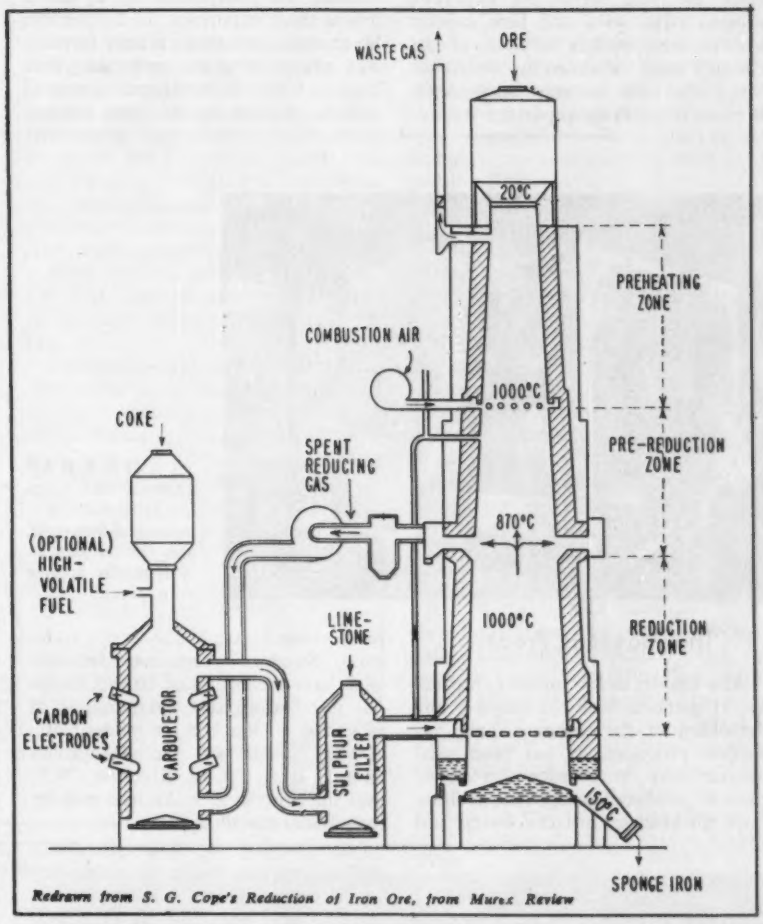
The Krupp-Renn Process

The Krupp-Renn process is a rotary-kiln direct-reduction installation which has been commercially applied in the Eastern Hemisphere but not yet in the Western. Since it is relatively old (invented by Krupp metallurgists in the 1930's), it also is well described in textbooks (again see Bray).

Most recent installation has been at Essen-Borbeck, Germany, where within about the last year six kilns, each measuring 110x4.6 m (about 360x15 ft—see photo) have been installed, the plant having a capacity of over 500,000 tpy of "luppen," the final product. Recently four large kilns were installed at Salzgitter-Watenstedt, Germany, and two in Spain. A Japanese kiln, built before World War II, has since been reactivated, near Kuji City, Japan, and has successfully treated low-grade titaniferous iron sands. Southwestern Engineering Co. of Los Angeles is American agent for the Krupp-Renn process, and operated a demonstration kiln at Pioche, Nev., during 1959, treating 12,000 tons of finely disseminated titaniferous iron ore.

The Process—Krupp-Renn reduces and semismelts iron, but does not deliver it in molten, but rather in cold solid, form. Ore is charged with an excess of solid carbon reducing material. Together the ore and reductant travel the length of the kiln, the carbon deoxidizing the iron oxides to form CO, which both reduces further oxide and burns to furnish part of the kiln heat. At its discharge end the kiln is fired with a gas, oil, or pulverized coal flame. Near the discharge end the temperature is high enough to partially fuse the reduced iron and gangue, which together are discharged as a pasty slag. Quenched in water, it is rendered brittle and easily crushed. After crushing, a single step of magnetic separation produces three products: "luppen," which are metallic iron nodules containing about 92% metallic iron (the magnetic fraction), tails, which can be sold for aggregate, and a semi-magnetic middling which is recycled to the kiln.

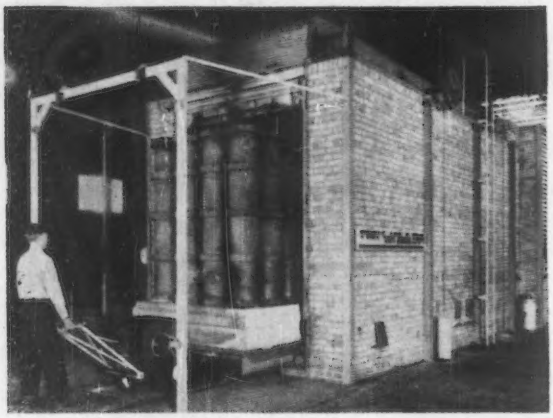
Krupp-Renn is well suited to treat low-iron, high-silica ores. However,



WIBERG-SÖDERFORS shaft furnace, commercial in Sweden since 1941, gives high reductant efficiency, needs strong, coarse ore bed to let gases pass freely.

LATEST commercial Krupp-Renn installation is six-kiln plant at Essen-Borbeck, Germany, built in 1959, with yearly capacity of over 500,000 tons of "luppen."

since the slag serves an important process role, silica and lime content of the ore (or flux content of the charge) must be carefully controlled. Since the iron becomes semimolten, it tends to pick up impurities such as sulphur and phosphorus. If the ore is low in these impurities, the luppen can be charged directly to a steel furnace. But since low-grade ores are often high in S and P, the luppen are most usually charged to the blast furnace itself, upgrading its burden (the blast furnace charge) substantially. For this reason, Krupp-Renn is often called a beneficiation process, though chemically this is incorrect, since it does chemically reduce the iron oxide.



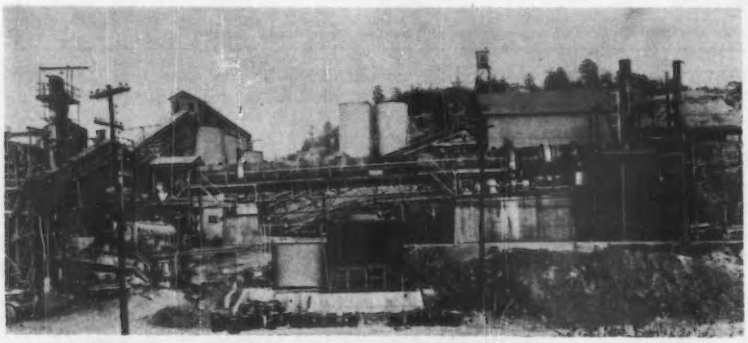
"SAGGERS," charged with high-grade concentrate, coke, and flux, enter the tunnel kiln in a Höganäs sponge iron plant.

The Höganäs Process

Also known as the tunnel kiln process, Höganäs is both the simplest and the oldest of the common direct reduction processes. It has been used commercially in Sweden for many years to produce sponge iron melting stock for electric furnaces. Latest and most modern installation is at Oxelosund, Sweden, where two furnaces each have a capacity of 50 tpd. Original installation, still operating, is at Höganäs. In the U.S., a modern 40,000-tpy plant of the Hoeganaes Sponge Iron Co. of Riverton, N.J., uses the process to make iron powder for powder metallurgy.

The Process—A simple batch operation, it consists of charging into sealed vessels, called saggers, a charge of ore, coke, and flux. The whole sagger is moved into a tunnel kiln and held at high temperature, about 2100°F, for 12-36 hr. Sagger is then removed, cooled, and emptied. Sponge iron has sintered into a coherent, porous cake. Saggers entering the tunnel kiln at the Hoeganaes Riverton plant are shown at left.

The process is simple and reliable, producing sponge from many types of ore. It is of limited capacity, though, and not highly efficient. Heat requirements of the kiln are high, though combustion of CO evolved from saggers gives some of the required heat. Principal cost item is sagger replacement. Ceramic saggers, which can stand higher temperatures than metallic ones, are also more fragile and more expensive. The more efficient the plant is built, through mechanical sagger handling, the more the advantage of low capital cost, present in a non-mechanized plant, is lost.



R-N PILOT KILN at Spaulding mine near Birmingham, Ala., has operated since 1954, produces 50-60 tpd of sponge iron which is briquetted for melting stock.

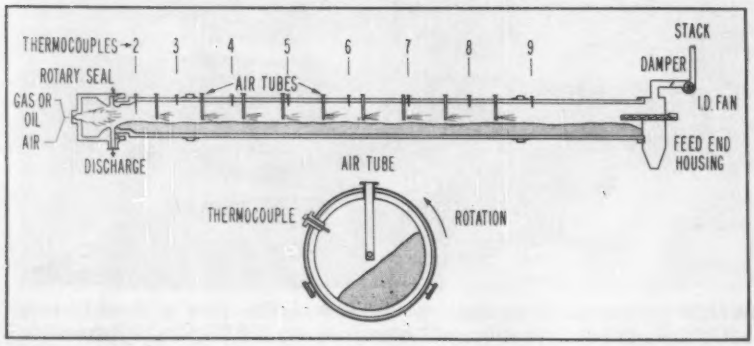
The R-N Process

In the semicommercial stage is the R-N process. That is, it is ready for commercial development, but so far no commercial development has come.

R-N is an outgrowth of efforts by National Lead Co. to find a way to deironize ilmenite ores. National Lead operated a pilot plant in Norway, for Norwegian ilmenites, in the late 1940's.

Because results seemed promising for an iron reduction process, National Lead joined with Republic Steel Co. in 1953 to build a pilot plant in the U.S. The two companies' initials gave R-N its name. A semicommercial pilot kiln was erected at Spaulding, near Birmingham, Ala., in 1954, and has operated almost continuously since then.

R-N is thus one of the best tested and best reported D-R processes. Numerous customers' ores have been run in plus-3,000-ton lots, and several



CLOSE CONTROL of temperature is achieved by secondary air tubes, thermocouples, located throughout kiln length. Each air jet is a "burner in reverse."

melting tests in steel furnaces have been made on R-N briquettes. A detailed description of the pilot kiln was given in MINING CONGRESS JOURNAL, December 1958, and some melting test results were reported in the April 1960 issue of CARBON AND GRAPHITE NEWS (published by National Carbon Co.).

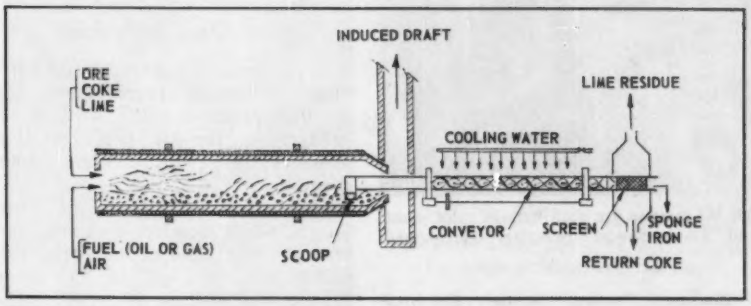
R-N Corp., of New York, was formed in 1957 to promote the process. Earlier this year it was announced that Head, Wrightson & Co. of England had contracted to build R-N plants world-wide.

The Process — R-N uses a rotary kiln (150x9 ft in the Spaulding plant) into which ore and solid carbon reductant are continuously charged. The coke in the charge, and the CO evolved from it, reduce the iron oxide as it passes through the kiln. The kiln is countercurrent-fired, with natural gas, oil, etc.; but instead of burning in one long flame extending into the kiln, the gases are introduced heated and only partially burned, and final burning takes place throughout the kiln at numerous air jets (see illustration). Air enters spontaneously because of a slight negative draft maintained in the kiln. This system enables close temperature control throughout the kiln.

Finished sponge and unburned coke are cooled in a rotary water-cooled cylinder, then are submitted to a rather intricate post-beneficiation system, which combines magnetic and gravity separation and up to three stages of ball-mill grinding. Unburned coke is recycled. Sponge is compacted, after drying, under very high pressure, to yield briquettes, with about 90% metallic iron. These, with modifications, can substitute for scrap in a melting furnace.

A wide variety of ores, grading from 35 to 70% iron, have been successfully reduced in the kiln. Of course, the better the ore, the cheaper the process operates, as with any process.

Since the process operates below the fusion temperature of iron, the iron does not tend to pick up sulphur, phosphorus, or other impurities. R-N claims to get very good rejection of S and P, except when the latter is chemically combined with iron ore.



FREEMAN CORP.'s co-current-fired kiln concentrates heat near feed end, avoids sticking, ring formation that often occur when reduced iron particles get too hot.

The Freeman Process

. . . is a variation on the rotary kiln, using co-current firing in contrast to the more common countercurrent firing. Freeman Corp. of Cap-de-la-Madeleine, Que., developed this process as a result of some 12 years of studying iron reduction methods that could be applied to Canadian ores.

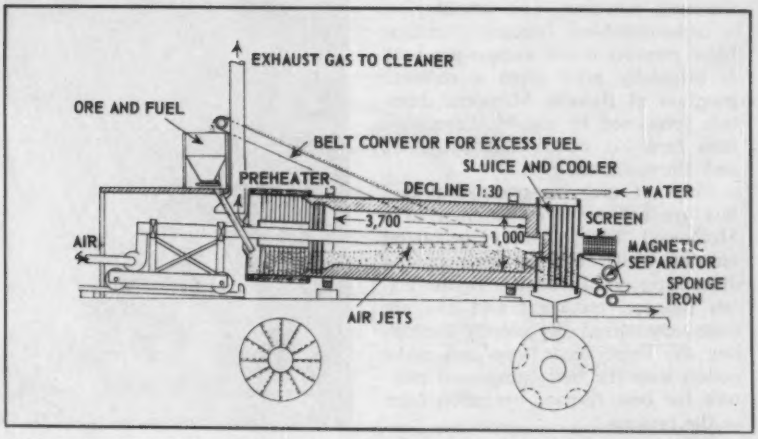
Pelletized ore, solid carbon reductant, and flux are charged to the kiln, as in a countercurrent kiln. Reduction is achieved in the same way, by the coke and its evolved carbon monoxide. Residence time of the pellets is 2-3 hr. The final sponge iron pellets, excess coke, and consumed lime are separated by the scoop-screw-trommel arrangement shown in the figure. The co-current feature attacks two of the problems that have often beset countercurrent sponge iron kilns: ringing or sticking of the charge to the walls, from fusion due to high temperature near the discharge end; and reoxidation of the sponge, again due to high temperature and oxidizing conditions near the discharge. Flame at the feed end heats the charge quickly to reaction temperatures, but the temperatures fall off toward the discharge end, where more-reduced iron is present.

Freeman Corp. has operated one pilot kiln, measuring 33x4 ft, for three years. It has produced both commercial powder, for which very high-grade concentrates were used, and electric-furnace melting stock. Both operations have been technically successful. Freeman plans to erect a larger, 100x10-ft kiln, with more elaborate waste-heat recovery devices, but it is not known when it will be built. The Freeman plant is the only known use of this process.

The Freeman process was described in the CANADIAN MINING & METALLURGICAL BULLETIN, August 1959.

The Kalling-Domnarvet Process

. . . is another approach to firing a kiln—see figure below. The kiln is neither co- nor countercurrent-fired, but as you can see, air is introduced through a central pipe. It oxidizes some of the coke in the charge to

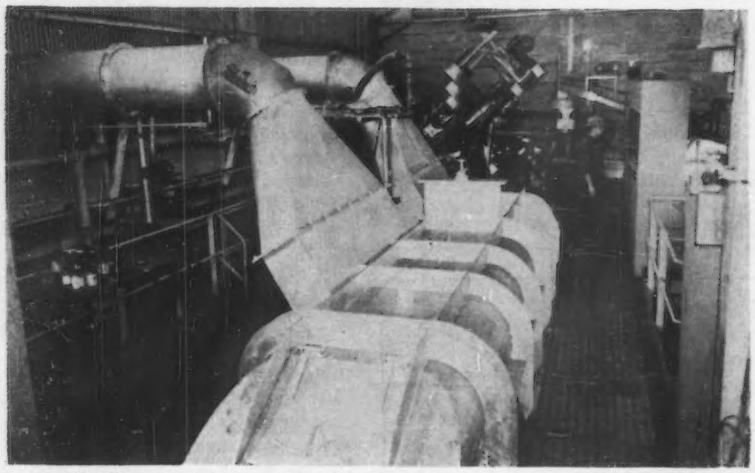


INTERNAL FIRING of Kalling furnace, rather than through either end, gives even distribution of heat, avoids troublesome overheating, ring formation at walls.

heat the furnace. This feature gives an even distribution of heat, and avoids overheating of the walls, a main cause of sticking.

This process was developed by Bo Kalling of Stora Kopparberg in Sweden, and a pilot furnace of 3-5 tpd capacity has been operated at Domnarvet. In Kenya, at the MacAlden-Nyanza mine, the British Colonial Development Corp. reportedly has operated a 10,000-tpy Kalling furnace for sponge iron to precipitate copper from leach solutions. But this plant is now reported idle, because scrap iron is available for the same use at a low enough price to make the furnace uneconomic to run.

The following four processes have been pilot-plant tested and publicly announced, but no commercial plants have been built.



TWO UNITS of Dwight-Lloyd McWane (DLM) process are seen here in pilot plant: Dwight-Lloyd down-draft sinter machine and "Flying Saucer" pelletizer, background.

The Dwight-Lloyd McWane Process

. . . which has been under development at the Dwight-Lloyd research laboratory of McDowell Co., Cleveland, was first made public last September, and has since been the subject of papers delivered before the AMC, the AIME, and the Assn. of Iron and Steel Engineers.

The process's three basic steps are pelletizing, in a "Flying Saucer" pelletizer, ignition in a Dwight-Lloyd sintering machine, and smelting in a submerged-arc electric furnace. Final product is hot molten pig iron. It originally grew from a research program at Battelle Memorial Institute sponsored by the McWane Cast Iron Pipe Co. of Birmingham, Ala., and Provo, Utah.

Fines of ore, low-grade coal and flux are belt-conveyed together to a McDowell "Flying Saucer" pelletizer, one of which can be seen in the illustration (background). In the pellets the ore, reductant and flux are intimately mixed. By closely controlling the three feeds, one can make pellets with the best component mixture for best furnace operation later in the process.

Pellets are distributed across the pallets of a Dwight-Lloyd sintering machine. Passing through the machine, they are first dried by downdraft hot gases passing through the bed, then ignited with a torch. (Illustration, above, shows the downdraft piping.) Because of the intimate mixture, ignition step causes a 50-70% reduction of the oxide to metallic iron. Prereduced pellets are then charged directly to the electric furnace, where final reduction occurs and pig iron and slag are tapped off.

McDowell claims several advantages to the process, including that: (1) it is fast (from ore bins to electric furnace takes only 15 minutes); (2) it is cheap and easy to set up, because of its simple machinery; (3) it is easy to control closely, and can be started up or shut down quickly.

The Orcarb Process

. . . uses the same three basic steps (pelletizing, prereduction, and electric-furnace smelting and final reduction) as the DLM process, but achieves them with different equipment.

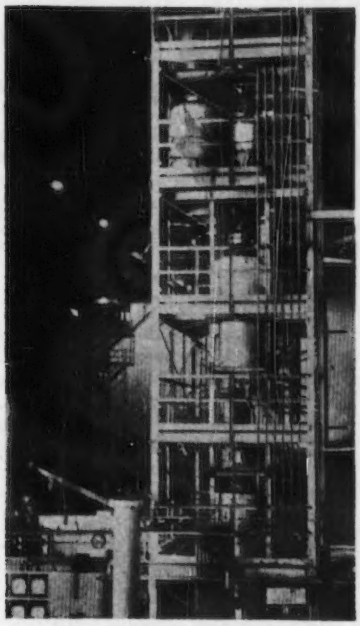
Swindell-Dressler Corp. of Pittsburgh, which developed Orcarb, operates a pilot plant at Indianola, Pa., which was described in CHEMICAL ENGINEERING, June 27, 1960. The process was devised by C. E. Lesher, and the pilot plant started operating in early 1959.

High-grade ore fines and flux are preheated, then mixed with low-temperature-coking coal fines, and the mixture is formed into "Orcarb" pellets in a heated rotating retort

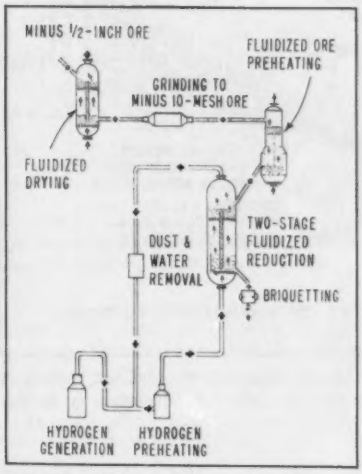
"ORCARB" is formed in heated rotating retort. Fines of ore, flux and high-volatile coking coal are blended, coal goes plastic and picks up ore to form pellets.

(illustration). The coal goes plastic and picks up the ore and flux. The second, prereduction step is carried out in a rotary kiln, which operates at 1700-1900° F, and into which the preheated Orcarb pellets are introduced. Pellets remain in kiln for an average of one hour, and become about 75% reduced. They are then smelted and the iron completely reduced in the electric furnace. CO-rich off-gases from the furnace are used to fire the prereducing kiln.

Thanks to the high degree of prereduction, Swindell-Dressler claims a power consumption in the furnace as low as 600-700 kwh per ton of pign iron. Very fine, largely minus-325-mesh, concentrates have been successfully processed.



U. S. STEEL'S Nu-Iron process has been pilot tested at South works, Chicago.



NU-IRON reduction is by hydrogen in two-stage fluidized-bed reactor.

The Nu-Iron Process

. . . has been developed by U. S. Steel Corp. since 1954, and a pilot plant of about 2 tpd capacity has been operated at the South works in Chicago.

It is a fluidized-bed process which uses hydrogen as the reductant. A two-bed vertical reactor vessel is externally heated by a surrounding furnace. In the upper bed fresh magnetite or hematite ore, sized to minus 10 mesh, is reduced to FeO (wustite), and in the lower bed, FeO is reduced to metallic iron. Hydrogen, which can be generated by any available means (see p. 98), passes upward through the vessel, reducing first the wustite, then the fresh ore. The off-gas is purified and recycled. The process is continuous with respect to both gas and solids. The final product is a 90-95%-reduced iron powder, which can be pressed into nonpyrophoric briquets for later melting. The process operates at about 1300° F and 15-25 psig; both ore and hydrogen are preheated to about 1600° F to supply the endothermic heat of the reduction reaction.

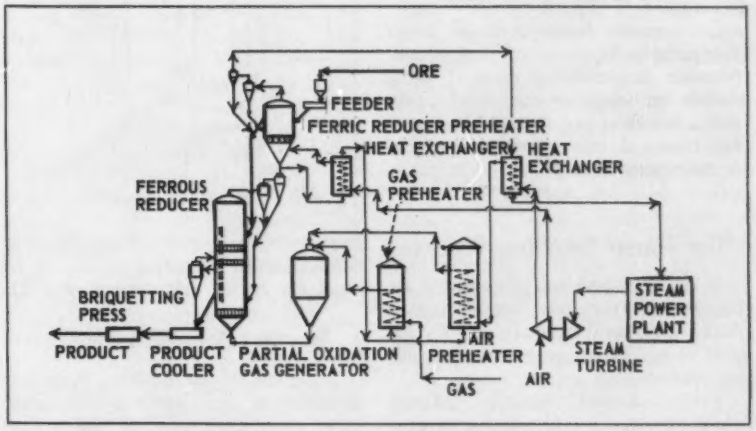
U. S. Steel's pilot plant has been technically successful, and the company has designed a 2,000-tpd commerical plant. But the process is not economic at this time, at least in the U.S. Should a favorable local situation appear, a plant may be built. A cheaper way of producing tonnage hydrogen than now exists would give Nu-Iron an economic shot in the arm.

JOURNAL OF METALS, April 1960, published a report on the Nu-Iron process and pilot plant.

The Esso Research—Little Process

. . . is another fluidized-bed process, which has some similarities to Nu-Iron. Here the reductant gas is a mixture of hydrogen, carbon monoxide, and nitrogen (the latter acting as a heat carrier). In ER-L, three fluidized beds are used. The first (upper) one is for ore-to-wustite reduction, the two lower ones for wustite-to-iron reduction. Reason for the two beds in the second step is that they allow a long retention time, without requiring an excessive bed depth. The process is continuous for both ore and gas. The reducing gases are generated by partial oxidation of natural gas, oil, etc. Off-gases are not recycled, but are applied to other plant uses—steam generation, preheating, etc. The process operates at 1450-1650° F and 1-4 atmospheres pressure. Final product is a sponge, containing 85% reduced iron, which can be briquetted to yield melting stock. Magnetic post-beneficiation can be used to upgrade the final product.

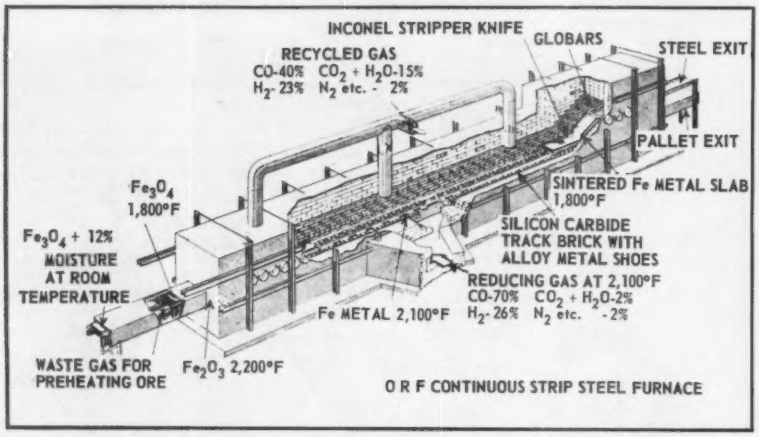
ER-L was developed by Arthur D. Little Inc. of Cambridge, Mass., who have tested it in a pilot plant and sucessfully reduced, in two four-month continuous campaigns, a variety of different ores ranging in grades from about 34 to 67% Fe. In collaboration with Foster Wheeler Corp., ADL has designed a commercial-



DESIGN for commercial plant using Esso Research—Little process has been made by A. D. Little and Foster Wheeler Corp., based on pilot plant work done by ADL.

scale plant, but none has yet been built. ADL reports, however, that a 50-tpd semicommercial plant may be built in the near future, which would be a stepping stone toward commercial development.

Some processes are in an early development stage. Here, for instance, are a few that have been announced or that have appeared in technical literature, but this is not by any means an all-inclusive list:



DIRECT STEEL furnace, developed by Ontario Research Foundation, produces small-size steel strip direct from super-concentrates. Flow of materials is shown.

The Direct Steel Process

. . . developed by Ontario Research Foundation — a specialized process for a special use. Treating very high-grade concentrates only, it yields, in one step, finished steel sheet, of maximum dimensions 3 ft by ¼ in, or rod or wire of maximum dia 1 in. Sketch above shows the Direct Steel furnace. Economic incentive for the process was fact that finished steel, if it could be produced, could command twice the price of plain reduced iron.

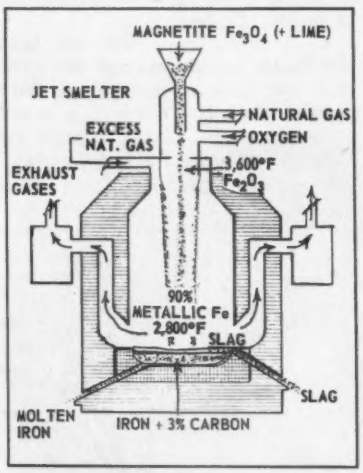
The Stelling Process

. . . under development by Stora Kopparberg in Sweden. A low-temperature fluidized-bed process, using carbon monoxide as reductant, it reduces hematite ore to yield high-carbon iron and substantial iron carbide. A description was published in JOURNAL OF METALS, April 1958.

The Flame Smelting Process

. . . developed and pilot-tested by the British Iron and Steel Research Assn. Formerly known as Cyclosteel, it is a two-stage process producing molten iron.

Finely divided, partially reduced ore is introduced into a high-temperature reactor, together with pulverized noncoking coal and oxygen. Droplets of molten iron and slag are formed and collected in a retaining hearth, while a reducing gas rich in CO and H_2 leaves the system at about 2700°F. Gas is then used to prereduce the ore in a fluidized-bed vessel.



SINGLE-STEP reduction is goal of Jet Smelting, under development at ORF.

The Jet Smelting Process

. . . on which Ontario Research Foundation has worked for over three years. (See sketch.) ORF is running tests on a 1-ton-capacity furnace.

Ore is introduced directly into a high-temperature natural-gas-oxygen flame (about 3600°F). Excess gas, introduced below the flame nozzle, is cracked by the hot ore particles to give reducing gases. These reduce the oxide particles rapidly as they fall through the furnace. Final reduction occurs in the slag layer. Bath is maintained at a high carbon level, and final product is molten high-carbon (3%) pig iron.

Finsider Process

Instituto Siderurgico Finsider, a property of the Italian government, has designed, but not yet built, a new type of shaft-furnace process, to be based on coal (JOURNAL OF METALS, August 1960). Process will be largely financed by the European Coal and Steel Community.

Taylor Process

. . . a recently announced method (CHEMICAL WEEK, Feb. 27, 1960) to make powder-metallurgy-grade iron with hydrogen. A batch process, it uses a tumbling furnace to which ore is charged and into which hydrogen is injected in successive stages. Stearns-Roger Mfg. Co. of Denver is reported designing a prototype plant for Western Steel Corp., Cheyenne, Wyo.

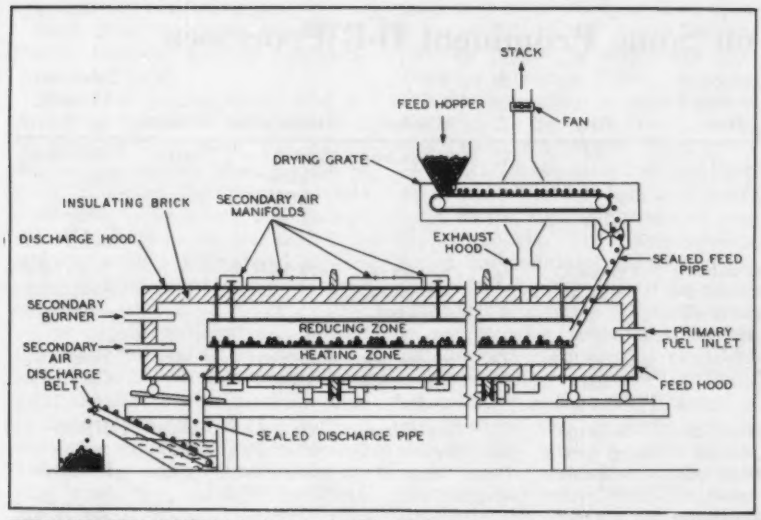
Allis-Chalmers Agglomeration-Reduction (ACAR) Process

This newcomer on the scene was made public just last month. It has been tested in a 1-tpd laboratory kiln at Milwaukee. Heart of the process is a "kiln-within-a-kiln"; see sketch on opposite page.

High-grade ore pellets are fed to the traveling grate, where they are dried and partially hardened by the kiln exhaust gases. They then pass, via a sealed pipe, into the inner, or reducing, kiln. Gases flow in through the primary fuel inlet, through the inner reducing kiln, then back through the cylindrical space between the inner and outer kilns and out the exhaust system. The ring joining the inner and outer kilns near the feed end forms a seal, and forces the fresh gas through the inner kiln.

Reducing gases are burned in the outer kiln; combustion air enters through the secondary air manifolds. Pellets, having spent about 2½ hr in the reducing kiln, drop off into the discharge pipe, then are quenched and collected.

Note that the process is a gas reduction process, yet no external gas



KILN-WITHIN-A-KILN is heart of Allis-Chalmers' new Agglomeration-Reduction process. Reducing gases are formed in inner kiln by cracking of hydrocarbons.

preparation equipment is needed. Fresh hydrocarbon gases are introduced (methane, propane, etc.), mixed with a controlled quantity of steam or air. These react in the inner kiln itself to give a H_2-CO mixture. The hot iron and iron oxide particles catalyze this cracking reaction.

In the pilot runs, Allis-Chalmers has successfully melted the reduced pellets in a water-cooled hot blast cupola, as used in foundries to melt scrap and pig iron, to get a molten iron containing 2.70-2.90% iron and 1.70-1.90% silicon.

The list of processes could go on and on. Including those which have been investigated in the past, and eventually dropped, there have probably been over a hundred direct-reduction schemes to make iron. There are many that we have not surveyed. Numerous recent patents have been granted that have not been developed into pilot plants. And we have not discussed two important types of processes:

(1) the conventional electric smelting of ores to yield pig iron, as in the Tysland-Hole furnace, which qualifies as direct reduction under the definition of any alternative iron-making technique to the blast furnace.

(2) magnetizing reduction of hematite ores, a partial reduction technique that produces magnetite, which can easily be concentrated magnetically—a technique becoming important in iron ore beneficiation.

What's the Outlook for D-R?

To some, direct reduction seems like an endless procession of bridesmaids which seldom produces a bride. If there are so many processes, with so much promise, if there has been so much interest, research, and publicity, why has direct reduction not entered the commercial picture more than it has?

The answers given here to the above questions represent the consensus of some authorities in the steel industry, men who are in a position to evaluate direct reduction's place in the iron and steel picture.

As one industry man has put it, there are two questions that an executive considering a new process wants answers to: What's it going to cost? Where are the operating plants?

The problems that have held D-R back have been mainly problems of dollars and cents, more than they have been problems of chemistry and metallurgy. The many technically successful D-R processes show that iron can be produced by ways other than the blast furnace. But as is true with the mining business as a whole, until a new process has shown that it can do a job more cheaply than an old one, it is not going to be adopted.

So far, in the U.S., no direct reduction process has been able to challenge the blast furnace successfully on a dollars-and-cents basis. Certain D-R processes have been commercially operating for some time in other countries, such as Sweden, Germany and Mexico, showing the fact that when conditions are right, D-R can be a successful competitor.

As mining men well know, local economics are all-important, for any process or any mine. Local costs are an individual factor at any operation. Until one specifies a site, an ore, fuel, reductant, electric power rates, shipping rates, taxes, labor market, one can't state the cost of any particular process. Where natural gas is cheap, a different process will be appropriate than where high-grade coal is cheap, and the same is true for cheap electric power, and so forth. For this reason, little emphasis has been placed on the costs of individual processes in this article.

It is generally safe to say that ton-for-ton, direct reduction capital costs are substantially less than those for a blast-furnace plant. For about a 1,000-tpd plant, many D-R plants would cost roughly one-half what a blast-furnace plant, with its necessary accessories, would cost. Below this tonnage, blast furnaces have become uneconomic. Hence, for low-tonnage operations the chances of D-R appear relatively bright. On the other side of the coin, the higher the tonnages, the less likely D-R is going to move in, certainly in the near future anyway.

The engineering companies that handle the various processes now in or on the edge of the market stand ready to give specific cost estimates for specific situations. In many cases, they have considerable pilot-plant data to go on.

Specifically, situations that should favor the development of direct reduction plants are: where electric power is available and cheap; where natural gas is available and cheap; where coking coal is very expensive; where there is a definite market for less-than-blast-furnace tonnages of iron; where there is a definite need for a flexible operation, with respect to startups and shutdowns, variable tonnages, or variable types of ores or products; where special types of ore or of product are involved. And there will doubtless be other specific conditions which will favor a D-R

Facts in Brief on Some Prominent D-R Processes

Process Name	Type of Equipment	Reductant (*)	Reductant Produced How	Ore	B or C	Final Product	Temperature	Pressure	Developer, Licenser, etc.
Dwight-Lloyd McWane	"Flying Saucer" pelletizer, D-L sintering machine, electric furnace	solid carbon fines	...	**	C	molten iron	ignition—about 2000° F	atm	McDowell Co.
Esso Research-Little	fluidized-bed reactor, 3-stage	carbon monoxide, hydrogen	partial oxidation of nat. gas or oil with air	various, −⅛ in.	C	sponge or briquettes, 85% red.	1450-1600° F	1–4 atm	A. D. Little Inc.
Freeman	rotary kiln, co-current fired	solid carbon fines	...	mag. or hem. conc's, ½-1 in. pellets	C	sponge pellets, 91.5% Fe°	up to 1850° F	atm	Freeman Corp.
H-Iron	fluidized-bed reactor, 3-stage	hydrogen	partial oxidation, water-gas shift, scrubbing	hi-grade mag. conc's, millscale	C, gas B, sol.	low-C iron powder, 98% reduced	reactor, 1000° F; passivation, 1200–1600° F	about 500 psig	Hydrocarbon Research Inc.; Bethlehem Steel
Höganäs	sealed "saggers" in tunnel kiln	solid carbon fines	...	rich ore, sinter, pellets	B	sponge, as sintered porous cake	about 2100° F	about atm	Höganäs-Billesholms, Sweden
HyL	fixed-bed reactor	hydrogen, carbon monoxide	catalytic steam reforming of nat. gas	rich lump ore, sinter, pellets; up to 1½", max 20% —¼ in.	B	sponge iron, 85% reduced	about 2000° F	about atm	Hojalata y Lamina; M. W. Kellogg Co.
Kalling-Domnarvet	rotary furnace, internally fired	solid carbon fines	...	various	C	sponge iron	**	atm	Stora Kopparberg
Krupp-Renn	rotary kiln, countercurrent-fired	solid carbon fines	...	hi-silica, low-grade ores	C	"luppen" 92% reduced iron may be hi-S	reduction, 600-1100° C slag exits 1200-1300° C	atm	Fr. Krupp, Germany; Southwestern Engg. Co., U.S.A.
Nu-Iron	fluidized-bed reactor, 2-stage	hydrogen	optional: partial oxid'n, cat. steam ref'g, etc.	hem. or mag. —10 mesh	C	powder or briquettes, 90-95% red.	1300° F	15–50 psig	U. S. Steel Corp.
Orcarb	preheating kiln, balling drum, rotary kiln, electric furnace	coking coal fines	...	mag. conc's low P & S, 50% —100 mesh	C	molten iron —2% carbon	1700-1900° F in reduction kiln	atm	Swindell-Dressler Corp.
R-N	rotary kiln, countercurrent & internally fired	solid carbon fines	...	various, —1 in., + 20 mesh	C	briquettes or sponge, abt 90% red.	1830-1970° F	atm	R-N Corp. (Nat. Lead Co. & Repub. Steel Corp.)
Strategic-Udy	rotary kiln, countercurrent-fired, & electric furnace	solid carbon fines	...	various, −⅜ in.	C	molten iron 1-2.5% C	solids leave kiln about 1700° F	atm	Strategic Mat'ls. Corp., Koppers Co.
Wiberg-Söderfors	fixed-bed shaft furnace	carbon monoxide, hydrogen	electric-arc-heated carburetor, from coke & hydrocarbons	mag's, some hem's, 2½-8 cm	C	sponge iron	max about 1000° C	slightly >atm	Stora Kopparberg, Sweden & N. Y.
ACAR (Allis-Chalmers)	traveling grate, dual concentric kiln-within-kiln	hydrogen, carbon monoxide	cracking of hydrocarbons w. steam or air within kiln	hi-grade conc pellets ½-¾ in. dia	C	iron pellets, 81% Fe°	about 1920° F	atm	Allis-Chalmers Mfg. Co.

B: batch.
C: Continuous.
*"Solid carbon fines" indicates in general coke breeze, char., etc., anthracite fines or bituminous coal of subcoking grade.
**Not specified in literature available to E&MJ.

approach for building plants.

How about the future for D-R in North America? Certain considerations seem valid:

Since D-R pertains to the steel industry, its future will ride with that of steel. A D-R plant will hardly displace an existing blast furnace in good condition. But there are two conditions to consider: obsolescence of old blast furnaces, and new iron-making capacity. When old blast furnaces pass on, what shape will their successors take?

One highly pertinent fact is that the blast furnace is by no means standing still. Without going into great detail, we can mention some of the many ways that blast furnace men are improving their machines. They have made great strides in upping production through beneficiating furnace charge. Operating with hotter blasts, with oxygen-enriched blast, or with the furnace under pressure, presents ways of raising production. Injecting oil or natural gas through the tuyeres gives a way to reduce coke consumption. Producing coke more efficiently, or from lower-grade and hence cheaper coals, offers a cheaper furnace operation. Developing castable refractories may cut expensive furnace relining costs and long downtime between campaigns.

All of these improvements mean producing more iron for the same amount of coke, or of dollars. The steel industry can get a good deal more out of its blast furnaces than it has so far. In this way it can expand its capacity greatly; some estimates go as high as 50%.

Another avenue of investigation has been the low-shaft blast furnace, which can use a cheaper, lower grade of coke since the coke does not have so great a mechanical load to support.

Of course, such improvements cost capital dollars. The same dollars would buy additional capacity in the form of D-R plants. The formula of individual economics will undoubtedly decide what route is taken. If metallurgical coke remains available, and the industry remains relatively centralized, modern blast furnaces may well be the preferred way. If the industry tends to decentralize, or to grow in small increments, D-R processes may benefit, individual local situations determining what processes will grow. Canada may lead the way in such developments. Mexico is already moving in such a direction, as the new HyL plants show.

Of course in any new D-R installations, financing will be the vital factor. As D-R processes become established, in local situations responding to local conditions, financial backers will move with more and more confidence.

Since D-R's future is intimately tied up with dollars and cents, one particular cost item, freight shipping rates, may be particularly important in the development of D-R plants. If the over-all economics of iron production ever made it cheaper to reduce ore to metal at the mine and to ship only the metal, not the gangue, to the steel centers, building of D-R plants would boom. Such dollars-and-cents reasoning has played a large part in the great development of iron-ore beneficiation in recent years.

Worldwide, another factor in which dollars and cents play only a partial role is the hard-to-define point of national pride. For the world's smaller nations, a home steel industry would be a source of prestige, and, more practically, a foundation on which other industries might rest. A successful D-R plant, in contrast to the blast furnace, would appeal in two ways to a smaller nation: It would be cheaper to build, and it would economically produce a smaller tonnage of iron, one that would meet a small nation's needs and not leave it with a large excess of iron that could not be used or sold.

The technology of direct reduction, developed by the ferrous metallurgist, may find applications in the nonferrous industries. For example, nonferrous processors can use the techniques of fluidized bed treatment or variations in electric smelting. The Sorel smelter of Quebec Iron and Titanium Corp., reported in E&MJ in March 1952, is an electric furnace process believed closely allied to direct reduction.

Chemistry Governs Reduction

The following section may help you to understand how direct reduction has developed, by pointing out some of the chemistry that the designers of direct reduction processes must deal with.

Iron appears in the earth's crust in a variety of oxide minerals, as a carbonate, as a sulphate, in sulphides and various silicates, and in other forms. The vast preponderance of commercially used iron ores, however, contain iron as one of the oxides.

Hematite, Fe_2O_3, the highest oxide of iron, contains 69.94% iron and 30.06% oxygen by weight. Magnetite, Fe_3O_4, the next highest iron oxide, contains 72.36% iron and 27.64% oxygen. These are the important iron ores occurring in North America. Other oxide ores with varying amounts of hydrating water associated are important in other parts of the world, notably in France and Germany.

Thus the highest possible grades of concentrate are 69.9% Fe for hematite ore and 72.3% Fe for magnetite.

Iron ore is mined mostly by open-pit methods, though often high-grade deposits are mined underground. If of high enough grade to be designated "direct shipping" ore, it is shipped directly to the smelter. Otherwise, as is being done more and more in the U.S., it is upgraded by a variety of methods, and the concentrates are shipped. With modern upgrading techniques, particularly for magnetic ores, very high-grade concentrates can be made, approaching the 72%-Fe composition of pure magnetite.

Let's talk a little about the chemistry that goes on in any iron-ore reduction process.

Practically, there are only three substances that are important in iron oxide reduction: hydrogen, carbon monoxide, and carbon. The reactions that take place are commonly shown as:

$$3\,Fe_2O_3 + H_2 \rightarrow H_2O + 2\,Fe_3O_4$$
$$3\,Fe_2O_3 + CO \rightarrow CO_2 + 2\,Fe_3O_4$$
$$Fe_3O_4 + H_2 \rightarrow H_2O + 3\,FeO$$
$$Fe_3O_4 + CO \rightarrow CO_2 + 3\,FeO$$
$$FeO + H_2 \rightarrow H_2O + Fe$$
$$FeO + CO \rightarrow CO_2 + Fe$$

Reduction of iron oxides directly by solid carbon is generally considered to be of minor importance, and the actual reduction, when some form of carbon such as coke or coal is charged to the reaction vessel, is by CO. Hence the reactions

$$C + \tfrac{1}{2}\,O_2 \rightleftharpoons CO$$
$$C + CO_2 \rightleftharpoons 2CO$$

are also of importance.

It is interesting to note that, speaking correctly, "direct" reduction should refer only to direct reduction of oxide by carbon; hence "direct reduction" is an incorrect term as it is widely used to denote non-blast-furnace reduction. But from wide usage, the term is firmly entrenched.

Of the three carbon monoxide reduction reactions above, the first and

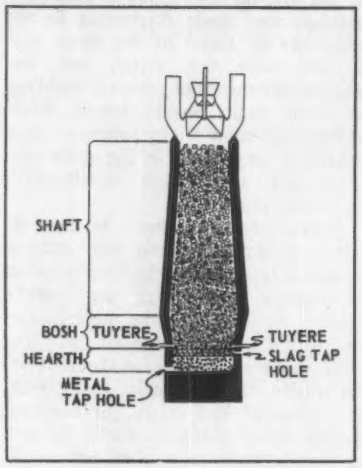


FIG 1—Blast furnace. Hot air blast, hot coke react above tuyeres to give CO.

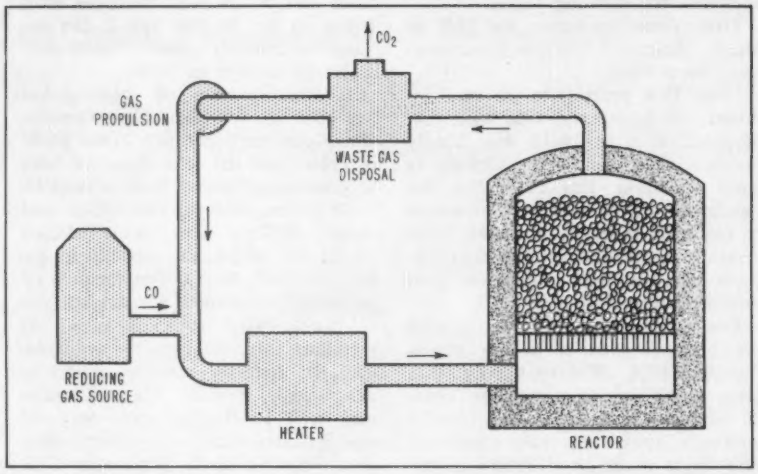


FIG 2—Any reduction system must perform the functions indicated in this idealized sketch. Reducing gas can be CO as shown, or H_2, or a mixture of the two.

third are exothermic, the second is slightly endothermic; and over-all reduction from hematite to iron liberates some 210 Btu of heat for each pound of iron produced. Of the three hydrogen reduction reactions, the first is very slightly exothermic, but the others are both strongly endothermic; so that over-all reduction of hematite to iron with hydrogen absorbs about 210 Btu per lb of iron produced.

Processes that use hydrogen as the chief or only reductant must therefore provide ways to supply the endothermic heat that the reactions require. This can be done by preheating the reactants above reaction temperature, by placing heating elements in the reaction chamber, or by surrounding the reaction chamber with an enclosing furnace. Processes which use primarily carbon monoxide must make provisions for removing the heat generated or utilizing it somehow in the process. Those processes that use mixtures of CO and H_2 have the opportunity, by using the proper mixture, of having a thermally balanced process or one that is unbalanced to whatever degree is convenient.

In the processes that use coke or coal as reductant raw material, the actual reductant, carbon monoxide, is produced by incomplete oxidation of the carbon with oxygen:

$$C + \tfrac{1}{2}O_2 \rightarrow CO$$

In the blast furnace (see Fig. 1, above left) this occurs near the tuyeres as the hot air blast meets the incandescent coke in the bed. In the rotary kiln, CO is formed as the carbon picks up oxygen from the iron oxide charge and from air in the kiln. For the processes that use gas reductants, a gas generator is needed (Fig. 2). Below in Fig. 3 are shown schematically some gas generation schemes. Figs. 2 through 5 are from a paper, "Gas Reactions in Reduction Processes," by J. Huebler of Surface Combustion Division, Midland-Ross Corp., Toledo, Ohio, presented at the May 1960 meeting of the Electrochemical Society. This paper gave an excellent review of much of the chemistry of iron ore reduction.

Fig. 3(A) shows a simple CO generator, using the reaction $C + \frac{1}{2}O_2 \rightarrow CO$.

Fig. 3(B) represents a CO generator using the reaction $C + CO_2 \rightarrow 2CO$. Here heat must be added; two reducing units are produced per unit of carbon. This is the principle of the carburetor in the Wiberg process. Steam can be charged in place of CO_2, giving the "water-gas" reaction, $C + H_2O \rightarrow CO + H_2$; again, two reducing units are formed.

Fig. 3(C) shows the "partial oxidation" process of natural gas with air. Here the reaction is $CH_4 + \frac{1}{2}O_2 \rightarrow CO + 2H_2$. Note that three reducing units are formed.

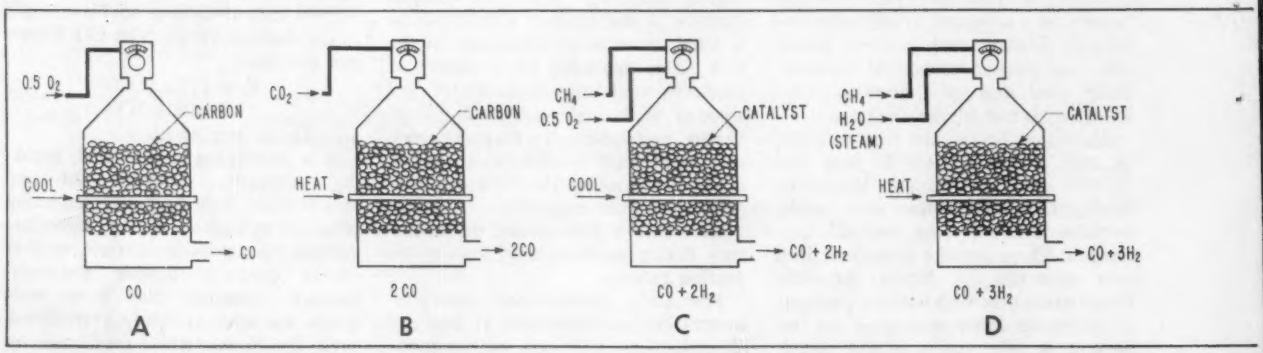


FIG 3—Schematic presentation of five gas generating systems. Principle of simple CO generator, A, is same as that used

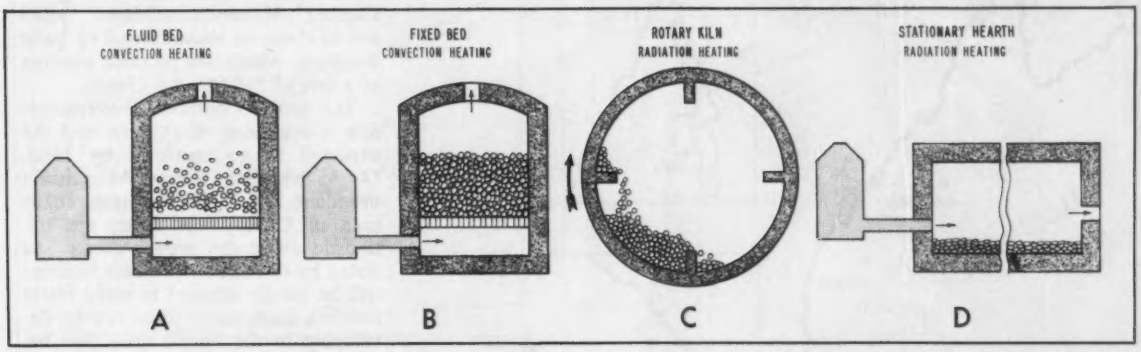


FIG 4—Four possible types of reaction vessel. In fixed bed, gases can pass down as well as up through bed. Kiln and hearth can handle various-sized material; fixed bed best sizes are from 1 in. to ⅛ in., fluidized bed from ⅛ in. to 200 mesh.

Fig. 3(D), the "synthesis gas" producer, produces four units of reductant per unit methane, by the reaction $CH_4 + H_2O \rightarrow CO + 3H_2$. Considerable heat is needed to promote the endothermic reaction.

To produce hydrogen, an apparatus like that in Fig. 3(E) is used. The first of the three vessels in the sketch is a partial oxidation generator; it could be a synthesis gas generator. In the second, excess steam is added and reacts with the CO:

$$CO + 2H_2 + H_2O \rightarrow 3H_2 + CO_2.$$

The unused steam and the CO_2 can be removed in several ways, leaving only the hydrogen. The hydrogen generator is a very complicated piece of equipment.

One factor in selecting a reductant for a sponge iron process is the degree of carburization wanted in the product. A hydrogen process, like H-Iron, can produce a carbon-free iron, which may be desirable for powder metallurgy or other purposes. On the other hand, a certain degree of carbon, which a carbon monoxide process inevitably causes, is often desirable for further furnace treatment.

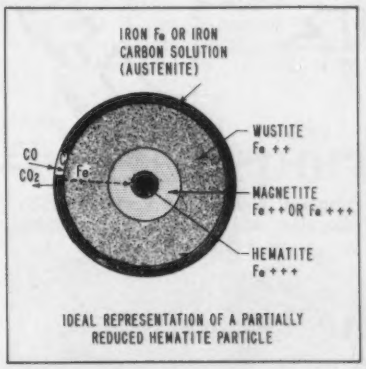


FIG 5—Idealized hematite particle, showing mechanism of reduction by CO.

In kiln processes, the degree of reduction is a variable factor, subject to the operator's control. Processes like R-N or Krupp-Renn, which yield a cold iron product for later melting, strive for a high degree of reduction. But in processes which feed the prereduced product immediately to an electric furnace, like Strategic-Udy or DLM, a lesser degree of reduction is practiced in the kiln or grate. The reason is economic; it appears more efficient to carry out the final stages of reduction in the electric furnace.

For those processes that produce a gaseous reductant, any hydrocarbon source (oil, natural gas, coke-oven gas, etc.) can yield the CO and H_2. Local economics dictate which should be used. For instance, Alan Wood's H-Iron plant at Conshohocken uses coke-oven gas; the Los Angeles H-Iron plant of Bethlehem uses natural gas.

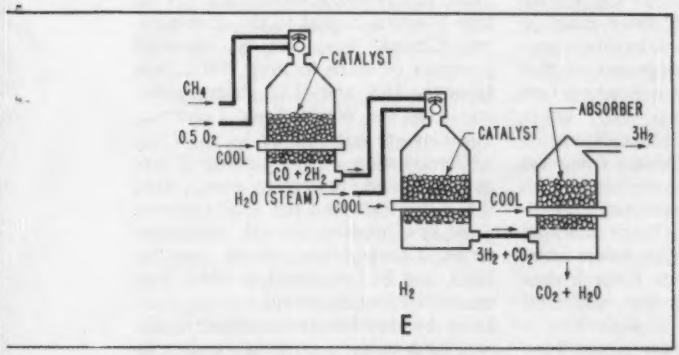
Hydrogen Faster Than CO

Hydrogen reduces iron oxides faster than does carbon monoxide because the hydrogen molecule, being smaller than the CO molecule, can diffuse faster through the solid material to be reduced.

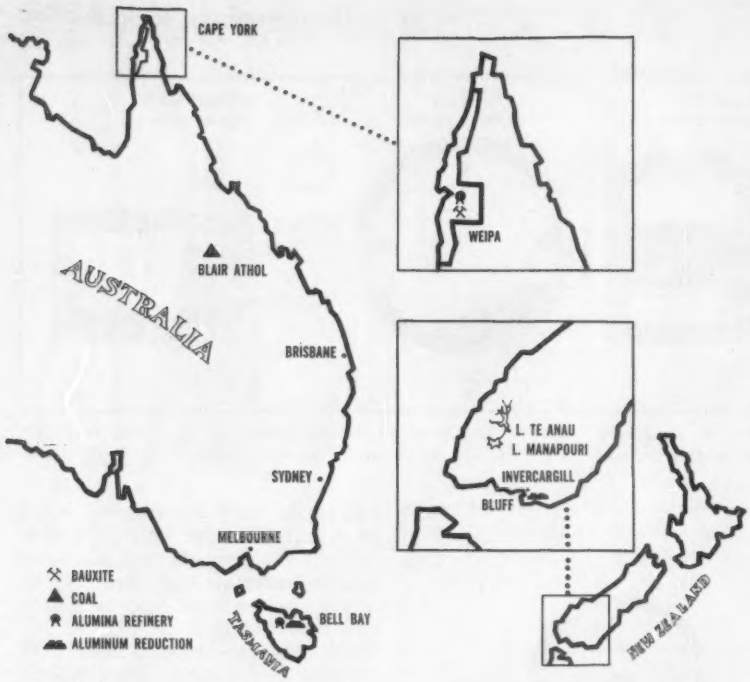
Fig. 5 represents schematically a pellet being reduced. Originally all-hematite, the pellet is attacked from the outside by reducing gas, which produces successively magnetite, wustite, and iron. Iron diffuses inward, converting each phase to the next-higher one; and at the wustite-iron boundary, gas reduction takes place and the gaseous product diffuses out and away from the pellet.

Wustite, which is generally shown as FeO, is not actually a stoichiometric compound, one Fe atom to one of O, but actually is a variable substance whose composition approximates $Fe_{0.95}O$. At temperatures up to about 1100°F, wustite is unstable, and cannot exist at equilibrium. In processes that operate above 1100°F, reduction goes from magnetite through wustite to iron; in lower-temperature processes, magnetite changes directly to iron.

E&MJ is grateful for the help that many people active in developing direct reduction have given, in furnishing copies of papers on the subject, in discussing and reporting the development of processes, and in commenting on future of D-R technology.



in blast furnace. Note complexity of hydrogen generator, **E**.



The three Kaiser-Consolidated aluminum development areas: Cape York, Australia; Bell Bay, Tasmania; Bluff, New Zealand. Hydro plant will tap New Zealand lakes.

Aluminum For The Orient . . .

KAISER ALUMINUM and Great Britain's Consolidated Zinc Corporation, Ltd. have announced that they will join in an intensive modernization and expansion of aluminum production facilities in the bauxite-rich Australia-Tasmania-New Zealand triangle.

Kaiser seized the opportunity presented by a deadlock in similar negotiations between Consolidated Zinc and Reynolds controlled British Aluminium Corp. Although total long range investment figures have not yet been released, Kaiser will allocate more than $10 million in 1961 for the development and expansion of Consolidated Zinc's Australian properties.

Four projects are planned, two of them on New Zealand. The New Zealand work will involve 1) construction of a 280,000 kw power generating system on the Te Anau and Manapouri lakes and 2) the construction of a 120,000 tpy (long) aluminum reduction plant at Bluff, near Invercargill.

In Tasmania, the combine will expand existing Bell Bay reduction works production capacity from 12,000 to 28,000 tpy (long).

The principal development will, however, take place on the Australian mainland. Consolidated Zinc has been working for several years through its sub-company, Commonwealth Aluminum Corp., on a prospecting and research program in the Weipa area of the Cape York Peninsula, the continent's jutting northeastern "finger." As reported in September, 1959, E&MJ (p. 188), Commonwealth has been engaged in a $450 million development project, of which $101-million had at that time been spent. Current Kaiser-Consolidated plans are to continue research and to build a refinery which will produce alumina at a rate of 360,000 tpy (long).

The projects outlined above represent a beginning effort only, and are expected to go onstream by 1966. D. A. Rhoades, Kaiser Aluminum's president, and L. B. Robinson, chairman of Consolidated Zinc, are optimistic about the growth factor. As stated by Rhoades, "The new facilities will be ideally situated to serve world markets, particularly those rapidly developing in the Pacific area. We believe that consumption will more than double in these areas by 1970." D. A. Rhoades also emphasized his belief that "the installation of new industrial facilities and the development of bauxite and hydro resources will make a substantial contribution to the economic growth of Australia and New Zealand."

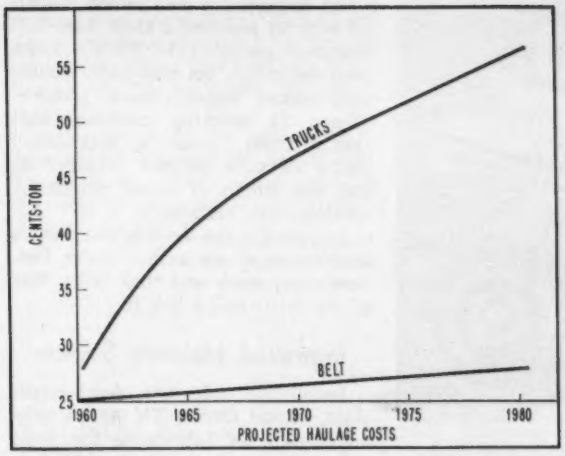
The merger, in which equity will be divided fifty-fifty between the two companies, is thought by Robinson to be a mutually advantageous blending of Kaiser's production experience and Consolidated's holdings. Consolidated brings to the venture concessions to bauxite reserves on Cape York Peninsula, concessions for hydroelectric sites in New Zealand, and options on coal reserves in Queensland, Australia. In addition, Consolidated recently presented a proposal to purchase two thirds interest in Australia's sole existing aluminum reduction works at Bell Bay, Tasmania, from the Government's Australian Aluminium Commission.

. . . And From Ghana's Bauxite

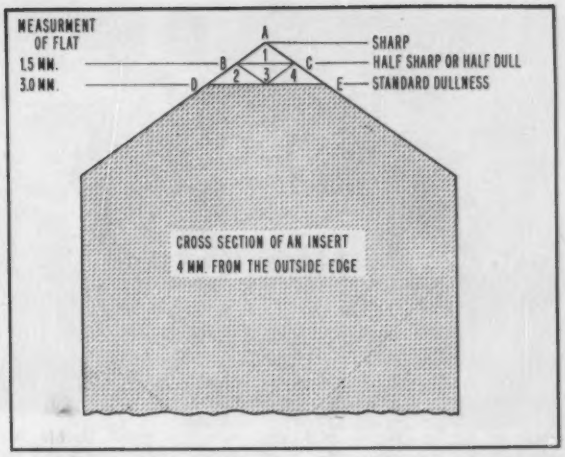
FIVE MAJOR NORTH AMERICAN aluminum producers, led by Kaiser Aluminum, have formed a consortium titled Volta Aluminum Co., Ltd. (Valco) and signed basic enabling agreements with the Ghanaian government for the development of that country's rich bauxite resources (see Washington Impact, p. 24). Other Valco members are Alcoa, Reynolds Metals Co., Olin-Mathieson Chemical Corp., and Canada's Aluminium, Ltd.

Valco's goal is to construct a $178-million 180,000 tpy (long) alumina smelter which will utilize power from Ghana's proposed Volta River hydroelectric dam at Akosombo, some 60 miles from Accra. The dam, long a Ghanaian dream, has repeatedly been delayed by the lack of investment prospects. However, the Valco Ghana agreement, which established a power revenue rate and a tax structure, is expected by Washington sources to lure Western capital to the dam project. Ghana has already received promises of loans totaling $90 million from the U.S. and U.K. governments, and from the World Bank. Construction bids are due Jan. 17.

Construction of the smelter is expected to get underway soon, after the consortium and the U.S. Government have worked out risk protection terms. Construction should start in 1961, and be completed in 1966. The smelter's alumina output will be marketed by member corporations in direct ratio to each member's equity in the venture.



DETAILED study of several haulage methods by U.S. Borax and Riverside Cement Co. boiled down to truck haulage vs belt haulage. Results of that study are clearly indicated in the above graph. Significantly, improvements in conveyor design allow belt flights that were not possible 15 or 20 years ago.



INCREASED insert life of 80% at Inco mines is obtained by sharpening to the half-dull point only. The reason is clear: Areas of four triangles shown above are equal; therefore, drilling wear from A to B is only one quarter that of B to D. Yet drilling speed difference was only 6% in tests conducted.

Mining 1960—As Reported at AMC

"AUTOMATION and remote operation of rock drills, hauling trucks and loaders are in the course of development and will most probably be extensively practiced in the future," according to I. Janelid, professor of mining, Royal Institute of Technology, Stockholm, Sweden.

Discussing the mining of huge orebodies in Sweden, Janelid also made the following points about Swedish mining development before AMC convention members:

"Automatic hoisting by means of skips is today the standard practice in new workings. By means of various signal devices and TV cameras, one man is now able to operate and check a long series of operations, and probably the development in large mines will be towards a haulage system which is controlled by means of data processing machines."

In drilling, Janelid noted the wide use of pneumatic-pusher drills, and told of improvements of feeds, including feeds of the simple "ladder" type.

"In deep-hole drilling, screw feeds and comparatively powerful rock drills are invariably used. These drills are extensively operated with light drill steels carrying a 1¼-in. thread. In operations of this kind, it is most important that the holes become straight. At Strassa, for example, a hole deflection of only 7 ft has been recorded when drilling 170-ft-deep holes. To ensure efficient dust removal and a high drilling rate, the flushing holes have been increased in size.

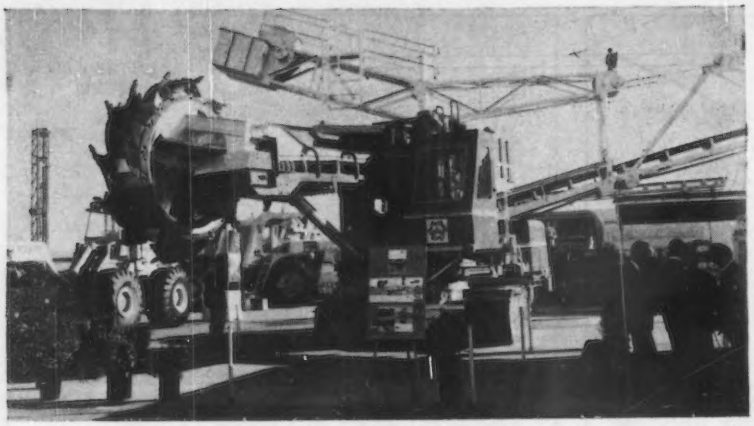
CONVENTION MEMBERS had a first-hand chance to see many of the new developments in mining machinery. Manufacturers presented well-planned, attractive booths.

"In the field of blasting, particular interest has been devoted to ammonium nitrate. Today, various mines invariably use ammonium nitrate also below ground and in narrow holes, 1¼ in. in diameter and 50-70 ft in depth. Experiments are being made to establish the adequate initiation, detonation stability, explosive gases, etc."

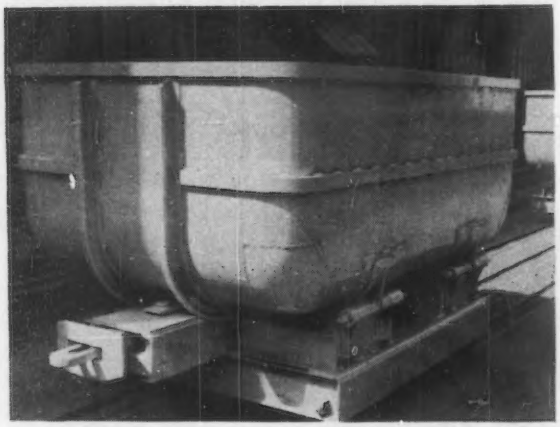
In addition to noting the increasing importance of fan drilling, smooth-surface blasting, and blasting of large underground rounds, Prof. Janelid made the following comparison of burn and angle cuts.

"When developing small drifts, the rock face is essentially opened up by parallel-hole blasting, while in large drifts and tunnels, cut-blasting is still the most economic method." (For small drifts Malmberget drills a 4-in. unloaded center hole while Grangesberg drills two unloaded center holes close together [Coromant Cut]—Ed.)

"Particular attention has been paid to the raising work. Long-hole drilling of raises up to 70 ft in length with hammer drills works well, but good results have been obtained in connection with diamond-drilling of up to 170-ft long raises. The Alimak raise climber is already well-known and, at Boliden, they have developed a new climber which is suspended from a



ONE of the machinery highlights was this small bucket wheel excavator. Used primarily for stripping, these machines are finding wider use in the mining industry. The LMG model shown is sold in the U.S. by Link-Belt Co.



TELLURIDE-TYPE ore car, displayed by C. S. Card Iron Works Co., has proved itself in the Ambrosia Lake mining area of N.M.

rope but has its hoisting machinery fitted in the climber. The mining methods have been developed into block caving and long-hole mining—methods which have effected labor economy and led to more concentrated working areas.

"In cut-and-fill mining, hydraulic filling has proved very favorable. To reduce the amount of boulder blasting and make automatic loading, haulage and hoisting possible, a coarse crushing plant installed below ground is necessary.

"In large drifts and tunnels, trackless haulage is frequently practiced but has now also been introduced in small drifts, for instance, by the adoption of Atlas Copco pneumatic dumpers and shuttle cars."

Rock Drill Repairs

The following cost-savings tip for rock drill repairs was offered by E. B. Olds, mine superintendent, Bunker Hill Co.

"The biggest saving we have effected in rock drill repair in recent years is an idea we got from the Anaconda Co., and that is of rebuilding our drifter shells. The worn guides of the old aluminum shells are cut off and new aluminum bar stock welded on. We cut the new grooves or guide channels 0.007 of an inch narrower than a new guide and then make it a practice to use only drills having used cylinders with the rebuilt shells. The cost of putting the new guides on is $78 as compared to $250 for a new shell."

New Drifting Method

A round in and a round out in 3½ hours at a cost of $29.14 per ft exclusive of equipment writeoff, is the result of new drifting methods at Britannia Mine, according to Donald W. Pringle, manager, and Herbert Shuttleworth, mine superintendent, Howe Sound Co., Britannia Div.

In the Britannia system, three men do all the work (drilling, blasting, mucking, servicing, etc.) Key to the fast mining, however, is the equipment they use.

At Britannia, a drill jumbo mounted with air legs and a D-99 4-in. drill mounted on a G.D. 2NCIO screw feed for a 5-in. cut hole eases drilling and makes longer rounds possible. Eimco 21 mucking machines load into a Train Loader, an articulating string of cars coupled together to suit the length of round drilled. A spotlight aids visibility.

Included in the work of the crew is installation of an airline, water line, vent pipe, track and rock bolts. Size of the drifts is 7 x 8½ ft.

Improved Hoisting System

Installation of new light-weight skips, closed circuit TV and a drip mechanism for lubricating the hoist rope with a penetrating liquid lubricant has improved hoisting at the Galena Mine, according to Norman Visnes, superintendent.

The new skips are designed to hoist in a narrow shaft from 4,000 ft. To eliminate flyrock around the skip dump, the door of the Card skip hinges down and forms a slide for the muck into the bin. Each skip weighs 7,786 lb and can hold 123 cu ft of ore.

With regard to TV, Visnes stated, "This installation has not only ended the problem of skips hanging in the dump, but with the hoistman viewing the dumping action, it has shortened the hoisting time cycle appreciably and has taken all the uncertainty out of the dumping procedure."

In an 18-month period, total repairs for the TV unit have cost less than $325.

Visnes offered this comment on lubricants: "The hoist ropes are lubricated with a drip mechanism at the sheave wheel. A liquid lubricant with penetrating qualities is used and has worked out well. Previously, we used a tacky lubricant which built up and accumulated on the rope. When water got into the core it was held there with the previous lube. This problem does not occur with the liquid lube, which also gets into the core better."

For the last four years, the Galena Mine has been experimenting with copper conductors in the core of their hoist ropes. Purpose of the cores is to get a signal to the hoistman while the cage is at rest or in motion. The safety dogs are also wired to the core so that the hoistman can receive a signal when they are actuated.

Although the conductors haven't functioned throughout the life of a rope yet, the idea is sufficiently attractive to continue experimenting.

Alimak Proves Value

"The Alimak Raise Method, using the Alimak Climber, has proved to be

a new, fast, economical method of driving raises at the Iron King Branch of Stattuck Denn Mining Corp.," according to Bee R. Waples, Jr., chief engineer.

After giving a thorough description of the climber, Waples offered the following tabulated comparison between the old and the new method.

	Average 9 Timbered raises	Average 3 Alimak raises
Number of men in raise crew	2	2
No. of 8-hr shifts worked per 24 hr	1	1
Tramming crewshifts used to haul muck	½	0
Bonus contract shifts per raise	67	43
Company time shifts per raise	31	16
Shifts lost ventilating raise	22	0
Height of raise	142 ft	142 ft
Dollar cost of timber per raise	$1,200	0
Man shifts required to strip a waste raise	48*	0
Total working days from beginning to end of raise	87	36

* Raises used as ore transfer and gob transfer are driven in waste outside the ore zone, and all timber must be stripped out.

"The bonus contract shifts required to complete a raise under the Alimak method is 64% of the shifts necessary to complete a timbered raise. The company time shifts have been practically cut in half. Twelve hundred dollars worth of timber is saved in each raise, ventilating time is eliminated, and raises are completed 2.4 times faster."

Tires in The Pit

Premature tire failure due to excessive heat is the most prevalent tire problem in modern haulage pits, said G. E. Danby, manager, sales development, Euclid Div., General Motors Corp.

"Increasing tire temperature decreases the tensile strength of the tire at a relatively fast rate. Over-heating tires is further compounded by the fact that rubber is a rather poor conductor of heat. While a hauling unit sits under a shovel or on a dump, the tires begin to cool, but the rate of cooling is relatively slow.

"Tires with regular tread cool at the rate of approximately 1° F per minute and tires with an extra heavy tread cool at the rate of approximately ½° F per minute. For example: if a tire heats up to the maximum permissible temperature during a certain part of a vehicle's hauling cycle, it will require approximately 20 minutes to bring the temperature down 20° if the vehicle is stationary and the ambient temperature is 60° F. In the case of the extra tread tires, it will require approximately 40 minutes to bring the temperature down the same 20°.

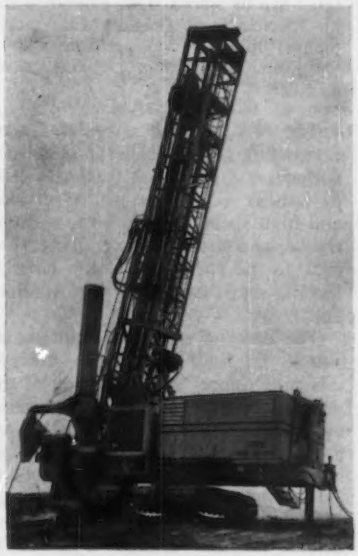
"The mining industry is no different from any other commercial enterprise. Competitive pressures always force mine management to constantly strive for lower cost tonnage. One of the usual economies consists of overloading vehicles and tires well beyond their rated capacity. This, combined with a modern off-highway hauler's ability to travel in excess of 30 mph, is conducive to short tire life. Excessive overloads and speeds are apt to increase rather than reduce haulage costs."

Looking to the future, Danby listed long-range projects of the tire industry. "One is the constant research which is going on using synthetic rubber to obtain the most desirable physical and chemical properties needed for tire construction.

"Another involves the testing of various fibres including steel wire for use in the construction of the tire carcasses.

"Last, but not least, is the development and testing of radial ply tires. These new tires, already in limited on-highway service, are being adapted to off-highway use. They are radically different in design from the conventional tire. A single ply of steel wire, or several nylon plys embedded in the carcass is aligned so that the strands are at right angles to the circumference of the tire. There are also steel cables embedded in the undertread and aligned in the direction of rotation of the tire."

A CENTER of attraction was an 8,000-lb cab of a mining shovel, which showed how space-age electronic controls are recruited to help offset mining cost factors. The Harnischfeger model was equipped for visitor operation.



ANGLE-FACE DRILLING, a technique that is reported to result in lower-cost blasting, better fragmentation, and more stable banks, is possible with the rotary drill introduced by Joy Mfg. Co.

Fighting Fire With Foam

Fighting underground mine fires with foam producing detergents was the subject of a paper given by Bernard W. Carey, assistant superintendent, Pickands Mather & Co.

Carey said, "The foam plug is simply a mine entry or tunnel filled tight to the back with soap bubbles. These bubbles being very light weight are moved along in a continuous plug to the fire area by the mine ventilating air currents.

"When the foam reaches the fire area, and providing it contains the proper amount of moisture, it tends to quench the fire by several methods. First, it greatly reduces the volume of air feeding the flames and thereby partially smothers the fire, second, the foam cools the fire area by evap-

oration of water vapor; and finally, it serves as a radiation shield.

"In most of the fire tests conducted by the Bureau of Mines, they found that the foam would not completely extinguish a fire but would effectively control it. By their definition this meant to quench the flames and reduce the temperature to a point where the fire could be fought directly and without protective clothing."

Carey emphasized that the foam plug technique "should not be considered a primary fire-fighting method. Ordinarily the best way to fight a fire is by direct attack with water or chemical extinguishers. However, for one reason or another, this may not be possible."

Industrial Engineering

With industrial engineering, "Where ratios of return have been calculated, for every dollar invested there has been a return of from $4 to $5, and there are instances of much higher returns," said Richard M. Stewart, director of mining research, and Stewart W. Hurlbut, senior research engineer, The Anaconda Co.

The authors went on to say, "It is noteworthy that application of I. E. is occasionally a matter of last resort. At least three operations consulted would not be active today had it not been for the controlling of costs achieved through crash I.E. programs."

The evaluation of industrial engineering was reached by surveying operations of 23 companies in the U.S. and Canada. Thirteen different I.E. functions were tabulated as to the percentage of departments performing them and it was concluded that, "no department in mining was found that practices as much of the full potential scope as do many in manufacturing industry."

The authors cautioned, "The mining industry in general is attempting to take a short cut by trying to do a professional job with inadequate use of professionals. Professionally trained industrial engineers are needed in larger numbers to augment the staffs of technicians and engineers with other backgrounds."

Trucks vs. Belt Haulage

Comparing four haulage methods, "a belt and underground crusher turned out to be the best . . . when operating cost, flexibility, capability of expansion, and capital expense requirements were all considered," said D. M. Cooper, senior mining engineer, U. S. Borax & Chemical Corp., and Peter Nalle, superintendent of mining, Riverside Cement Co.

IMPROVED RIPPERS mean more material can be ripped. This point, designed by Electric Steel Foundry Co., tackles tougher material and performs two to ten times longer than previous points.

The four methods considered were (1) underground crusher and belt to surface, using present trucks to haul to crusher (2) underground crusher and high speed electric bottom dump trucks and trailers to haul crushed rock to the surface (3) skip hoist in incline shaft and (4) vertical shaft and hoist.

The detailed study, "Economics of Truck vs Belt Haulage," brought this conclusion: "An evaluation of the present system vs the proposed system by the discounted cash flow technique gives a return on the investment of about 15% with a payout of six years.

"Preliminary study indicated that three or four levels can be mined and hauled to the crusher by electric truck haulage. This represents an elevation difference of 330 or 440 ft, which can be readily handled by the electric truck system without an undue increase in labor and truck force.

For both companies, "trucks will continue to play an important part in the mining planning. However, the vertical lift by trucks will be minimized and the brunt of the elevating of ore will be taken by conveyor belts set at the maximum slope possible. It is interesting to note also that both mining companies have designed belt flights which, 15 or 20 years ago, would have been impossible because of the belt tension requirements.

"The studies of both companies have indicated substantial ultimate savings by utilizing belts for elevating ore, in addition to other "fringe benefits" such as safety, reduction of maintenance headaches involving rolling stock, fewer personnel, ease of increasing or curtailing production, etc. This saving will not be made without the expense of additional capital requirements; but in each case, when analyzed, a reasonable return on the investment has been indicated."

Underground Drilling at Inco

Perhaps no other mining company pays as much attention to underground drilling as International Nickel Co. of Canada.

In their operations in the Sudbury District, "more than 16-million ft of airleg drilling is done annually requiring 1,400 machines and consuming 33,000 pieces of ⅞-in. hexagonal tungsten carbide insert steel," according to J. H. Dewey, drilling research engineer.

"In addition to the airleg drilling, 2.6-million ft of hole is bored annually for blasthole mining and undercutting for caving. This program requires 100 longhole machines and consumes approximately 8,000 tungsten carbide detachable bits, 26,000 rods and 30,000 couplings."

It is no surprise, therefore, that Inco regularly tests and evaluates airleg steel, carbide inserts, airleg machines and longhole drilling equipment. As a result, they have determined which equipment and methods are best suited for their operations.

In the area of research and development, they have suggested machine modifications to manufacturers and have received better equipment. Some of these include more powerful drills, reverse rotation of steel, and positioning of feed motors.

Daily inspection and scheduled maintenance are part of the Inco program. This work is the responsibility of a drill repair foreman and a staff of fitters who also maintain air hoists, mechanical loaders and associated miscellaneous equipment.

Final outcome of one research program was "the development of a drilling truck designed for use with five airleg machines. Maintenance and delays are virtually eliminated since a drill can be quickly replaced. Two machines are operated from an elevated and extended platform on the truck and three others at drift level beneath the platform. The machines remain connected to common air and water outlets on the truck and can be put into operation or removed from the face as quickly as with the jumbo.

"Similar trucks have been designed for regular drifting operations; these trucks are fitted for three drills, providing a spare machine in readiness for immediate use in the event of a failure."

As to future drilling equipment, "opportunities for improvement in underground drilling equipment and

methods have been apparent from drilling studies at Inco.

"Important economies can be seen by developments that would enable still further reductions in hole size. New steels would have to be developed possessing greater fatigue strength yet compatible with forging and heat treating processes.

"Smaller drills striking lighter and more rapid blows which would be more suitable to the performance of the lighter steels and less fatiguing to handle would also have to be designed. Other factors helpful to this development would be more powerful explosives, and methods for denser loading.

"A large saving in drilling labor would be possible by the use of such light machines and steels supported by a framework of drill mountings designed for the mass drilling of development rounds by a single operator. The framework would be constructed with sufficient mountings to provide one machine for each hole to be drilled and could be arranged to a pre-determined pattern.

"The drills would be equipped with multistage telescopic stoper-type feed to restrict weight and bulk and provide sufficient travel for long-holes to be completed with a single steel. The mountings should be simply constructed for easy replacement of a drill in the event of failure. A special device, possibly in the nature of a template would have to be developed for collaring.

"With the multiple drill unit it would be possible to drill off an entire round with little more than the time now required to drill a single hole. The unit would be much easier to maintain than the power jumbos and capital cost would be much less. Similar rigs could be designed for other development work such as raising and sinking.

"Directly the opposite of a multiple-drill unit would be equipment for complete removal of development rounds by drilling a single large hole. Machines are already in use in Europe and on the Continent for drilling holes of this nature in softer formations and extensive research is now being carried on by the manufacturers to design similar equipment for hard rock drilling.

"Underground hard rock rotary drilling equipment which would drill 12- to 16-in. holes 200 ft long would make it possible to replace costly stope raises where hydraulic fill is used. This would yield important economies in development costs and also eliminate bad ground conditions frequently caused by the raise opening in the stope backs. The drill hole, when not being used for hydraulic fill, would provide a stope ventilation outlet by installing an exhaust fan at the collar. Supplies would be provided from the level below.

"A movable platform for use in cut-and-fill stoping which would enable both drilling and mucking to be carried on independently of each other is regarded as a logical future development. The platform, power equipped for movement to and from the breast, would probably be suspended from some form of track which could be readily advanced after each blast. The platform could also be used in roof bolting and scaling.

"Long-hole drill performance would be improved by a new mounting which would hold the machine in direct alignment with the drilling forces. With the present mounting these forces tend to push the machine out of alignment causing excessive drill maintenance and rod damage and creating heavy vibration which reduces rate of penetration and general performance. Other improvements in long-hole drilling operations would be light drill carriage for use in small blasthole drifts to reduce move and set-up time, and increased automation to enable multiple drill handling."

New Initiating Systems

Two new developments in initiation of blasts in mining were discussed by H. J. Poel, manager, technical service section, E. I. du Pont de Nemours & Co.

The first, a low energy detonating cord (LEDC) is "virtually noiseless when compared with ordinary detonating cord." LEDC contains only 2 grains of explosive per foot (compared to 40 to 60 grains per ft for ordinary detonating cord) and 150 ft of LEDC makes about the same amount of noise as one blasting cap.

"LEDC and the other components necessary to make it work in trunk line systems have only been available for the last six months or so. Prior to its being put on the market, it was extensively field tested at several quarries, including some of the New York Trap Rock Corp. It is now being used at a number of operations in the country where air blast and vibration are serious problems."

The second development is primarily of interest in underground mining. "For the first time, precisely timed regular delay electric blasting caps are available. All caps of any given period will fire before any cap of the next period, so that there is no overlapping. This new series of caps has given better fragmentation in virtually every operation in which it has been tried and has also provided better control of overbreak in tunnel and drifting rounds."

Uranium Mining Costs

With a stripping ratio of 1:18.5, direct costs of Vitro Chemical Corp.'s mining operations in the Gas Hills, Wyo., area average $4.63 per ton direct ore, according to Roy Coulson, division superintendent. Lifting costs .87¢ per ton.

With rubber tired scrapers, stripping costs .17¢ per cu yd, with an additional .04¢ charged to blasting. Vitro employs four DW-20 scrapers and two D-9 pushers to do the stripping. In 1959, they moved 2,339,000 cu yd.

Although pit wall slopes are in the order of ½ to 1 in the area, the safety record is very good.

Front-end loaders, shovels and backhoes used to load ore are controlled by an ore-control man using a counter, Coulson said. Operators work around the ore pods with the front-end loader and shovel, he added, removing the waste material first and then the ore. The backhoe is used to dig out the narrow, sinuous ore channels as cleanly as possible.

Open Pit Blasting

Blasting at the Iron Mountain Mine of Columbia-Geneva Steel Div., U.S. Steel Corp., in dry holes is by a mixture of ammonium nitrate and Composition B, according to Emery C. Olsen, supervisor of mine inspection.

"The Composition B and ammonium nitrate are loaded directly into a conventional truck-mounted cement mixer and the blasting agents are transported to the blast area. The mixer is also used to prepare ammonium nitrate and fuel oil mixes, the oil being supplied from a tank mounted in front of the mixer barrel on the truck.

Olsen discussed a recent innovation in secondary blasting. "A ball of detacord is made up by forming several loops and this serves as the primer. This ball is inserted into the secondary drill hole.

"A 50-50 mixture of dry ammonium nitrate prills and Composition B is then poured into the hole. This practice achieves the objective of eliminating the electric cap and dynamite primer.

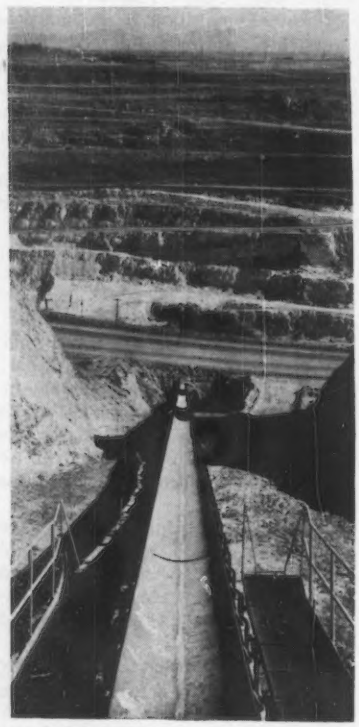
"The detacord protruding from the charge is tied on to the detacord trunk line and the process continued until all holes are charged and connected. Care is taken that all detacord is kept taut.

"Following the necessary safety precautions, the blast is initiated. Results have proved to be very favorable and experimentation continues to determine the most effective size of charge with this type blasting."

VIEW of main drive station. Belt tension is eddy-current regulated by varying load strains. Acceleration stress is limited by automatic torque control.

CONVEYOR during construction, showing road tunnel and troughing idlers.

Open Pit Conveyor Lifts Borates 315 ft on 18° Incline



30° TROUGH permits 27% flow increase over 20° trough. Crusher is in the pit, beyond the haul road.

FULL SCALE OPERATION of a new steep-rise ore conveyor system is expected in early 1961 at the United States Borax and Chemical Corp.'s huge open pit sodium borate mine at Boron, Calif. It is designed to move crushed ore up an 18° slope from the floor of the pit to the rim, a linear distance of 1,300 ft. Total lift: 315 ft.

In 1955, when U.S. Borax reached a decision to convert its Boron mining operations (begun in 1925) from an underground room and pillar method to an open pit system, removal of the ore was an important consideration facing company officials. A detailed study of several haulage techniques revealed that trucks should be used until the pit had been sufficiently developed to allow a permanent belt installation. Hindsight shows that this was the right decision for several reasons: 250 ft of overburden had to be cut away, major structure had to be crossed, and the crusher station had to be placed in the ore. Postponement of the belt haulage project allowed the crusher station to be located in the footwall of the orebody.

After studying several alternate methods, it was decided that the most favorable time to place the belt conveyor and crusher station in the pit was after three years of removal. During the initial phase of open pit mining, begun in 1957, the ore was blasted, scraped, loaded into trucks and transported to the surface along a spiral haulage road—approximately 2½ miles—to the crusher at the top of the pit. When the belt is placed in service, blasting, scraping and loading will continue as before, and some trucks will be used to transport ore from electric shovels to the new hammer mill at the bottom end of the belt system. However, the conveyor will transport as much ore in three hours as the trucks did in eight (see chart on p101). It will do what it was intended to do: provide increased flexibility in meeting future ore demands, and reduce the cost of transporting the ore. Further, it has been designed to handle a substantial increase in ore requirements without constant additional capital outlays.

Without the conveyor, it would have been necessary for the company to begin operating two shifts daily by next year to keep abreast of the growing ore demand. The new system will postpone the necessity for a second shift until 1966. It will eventually result in a two-to-one economy over truck haulage, and the saving is expected to give a good return on the investment over a 15-year period.

DETAIL of troughing and return idlers, which are housed in 17-ft sections.

At the new crusher station, trucks will dump their ore into a 90-ton bin. At the bottom of this open trough, a 72-in.-wide pan-feeder moves the material into the crusher. The new hammer mill, a 91,000-lb unit, has a 54x 72-in. opening as compared with the 42x64 in. of the old crusher.

These features are expected to minimize the downtime that had formerly occurred when the larger pieces of ore plugged up the opening of the smaller crusher, often necessitating secondary blasting.

The crusher's sturdy direct-coupled design is expected to minimize failures due to fatigue.

The speed of the eddy current coupling that drives the feeder is controlled by amp requirements of the main crusher motor. Thus, if the crusher is loaded, the motor's high amp requirement cuts back the feeder speed and prevents the crusher from becoming overloaded. But the main advantage of varying the speed by amp control is that the crusher's full capacity is utilized at all times, since the fines go through faster than the coarse. About 75% of the ore crushed by the hammer mill is minus 4 in., and the remainder minus 10 in.

This material passes onto a 60-in.-wide belt feeder, where tramp iron is picked out by a magnetic separator. Picking idlers on the belt system take out bits of timber that have gone through the crusher. A dust collecting system at the crusher discharge chute keeps the area dust-free.

Ore then flows to the 42-in. main conveyor belt, which rises up the slope to the head section at the pit surface.

To maintain the 18° slope of the conveyor, it was necessary for the installing contractor to burrow a 10-ft-dia tunnel under a section of the haul road, about midway up the incline. The tunnel is shielded with corrugated iron, and extends a length of 115 ft. At point of entry it is 35 ft below the roadbed, tapering to 5 ft under the roadbed on its way up the slope.

Belt material is five-ply nylon-rayon fabric, ¾ in. thick, which will withstand tensions up to 44,000 lb. Belt idlers are angled at the European-favored 30°, rather than the 20° trough that is standard in the United States. The steeper trough permits 27% more material per hour to move up the conveyor.

Each of the unitized idler-support sections is 17 ft long, and contains five carrying idlers and two return idlers of rubber roll design. The return idlers slope 10° toward the center and tilt 2° in the direction of belt run.

On the lip of the pit, a head section of plate-frame design contains driving apparatus to power the belt. By virtue of this design, drive and take-up of the conveyor are built in a single unit. The primary drive station is a 42-in.-dia pulley with rubber herringbone lagging. This is connected to two right-angle, 58-rpm gear reducers, and driven through an eddy-current coupling by two 200-hp motors. Belt speed is 600 fpm.

Two holdbacks mounted on the primary drive shaft, and one mounted on the secondary drive shaft, prevent the belt from rolling back. Thrustor brakes are installed between the reducer input shaft and the eddy-current coupling output shaft.

Eddy Current Regulates Torque

Since a too-rapid build-up of torque during acceleration would produce a shock wave that would cause undue stress to both the belt and the conveyor equipment, eddy-current couplings were employed. These accurately control the torque at any level.

A new electrical tension device automatically varies the tension on the belt as the load varies and eliminates the need for cables, counterweights and superstructures. Thus, only needed tension is applied, an innovation which prolongs belt life.

The take-up device employs an eddy current coupling and solenoids. To preset the tension control system, it is simply necessary to calculate minimum and maximum tension requirements. These figures are then translated into the amount of torque required at the eddy-current coupling to supply the needed tension to the conveyor belt.

In addition to the automatic torque control system, the take-up is equipped with a current-response relay connected to the input lead of the main drive motors. Excessive current in the main drive motors caused by belt overloading will cause the current response relay to cut off the torque control circuit, and 100% torque will be exerted and maintained until the current signal from the main drive motors returns to normal.

To energize the conveyor system, the take-up motor is started, then the main drive motors are turned over and all brakes on the system are energized. When the motors have reached maximum speed, the take-up eddy-current is excited and the solenoid brake on the take-up is released, so that 100% torque is exerted at the take-up eddy-current coupling and maximum take-up tension is applied. The main drive eddy-current couplings are then excited, and the thrustor brakes on the main drive are released.

After maximum belt speed is reached, in 2½ minutes, 100% torque is released and take-up control becomes regulated by the current, allowing the automatic control circuit to become effective.

Safety Cut-off Provided

A safety mechanism installed in the torque control system will cause the conveyor to shut down if the eddy-current signal from the take-up motor is not strong enough.

At the discharge end of the conveyor the crushed ore is braked against a splash plate. It falls onto a wobbler feeder and the flow is diverted 90° onto a 42-in.-wide stacker feed conveyor belt. The finer material (minus three in.) filters through bars and forms a material bed on which the larger material drops, thus protecting the belt from damage. The stacker feed conveyor carries the ore to a stacker for stockpiling. The existing stacker conveyor was extended 110 ft to connect with the new system at the head section.

Closed circuit television is being utilized so that the operator can observe the position of the stacker and the stockpile. Another camera permits observation of the conveyor transfer point so that any congestion can be easily detected.

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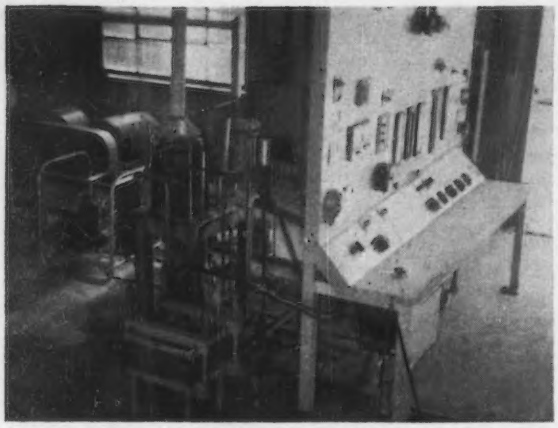
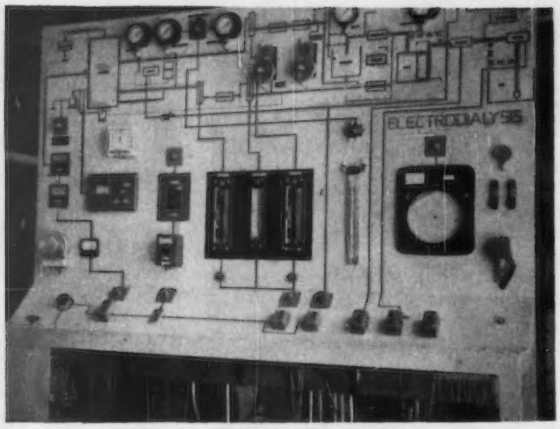
D.M. Cooper—senior mining engineer





THE ELECTRODIALYSIS PLANT installed at the sea water conversion project, University of California, has a steam water heater, 30-kw motor generator set, diatomite filter station, venting tank for electrode gases, and electrodialysis stack behind the control panel. The plant is automatic for minimization of operating costs, and controls on the panel are interlocked for safety. This system is set up to evaluate a range of sea water salinities.

Electrodialysis Process May Solve Sea Water Demineralization Problem

Within the next two years Freeport, Texas, San Diego, Calif., Webster, S.D., and Roswell, N.M. will get drinking water from salty sources, as part of a Federally subsidized program to find the best conversion system. The tiny villages of Coalinga and Oxnard, Calif., are already obtaining their water supply from brackish underground pools nearby. Electrodialysis, successfully employed at Coalinga and Oxnard, is one of the systems now getting close attention in this search for economical demineralization of salt water.

P. M. RAPIER

ELECTRODIALYSIS, the use of electrical potentials to trap concentrated brine between membranes composed of ion exchange materials, has gained a firm place in the U.S. economy through successful test installations and full-scale operations. Although it is a complicated procedure, these projects have resolved most of the economic difficulties of the membrane system, so that commercial units for demineralization of brackish waters are available now.

Investigation continues on broader application of the process than simply the production of water. The Union of South Africa has conducted an intensive study of electrodialysis through its National Chemical Research Laboratory in Pretoria (E&MJ, Jan. 1958, p 84). Faced with the necessity of purifying 2½-million gal per day and upwards of water containing about 4,200 ppm of dissolved solids, Orange Free State gold fields introduced electrodialysis desalination, at a cost of 35c per thousand gal. Electrodialysis can decontaminate mine tailings and industrial waste ordinarily dumped into rivers. Valuable acid from pickling liquors in steel mills can be recovered and reused if some presently proposed processes work out as anticipated.

Best electrodialysis method is the cell arrangement (Fig. 1), with various modifications as to size, spacer geometry, and electrode compartments. Immediately evident is the similarity of this arrangement to a conventional filter press of the plate-and-frame variety.

The membranes are permselective; that is, they are permeable to ions bearing a given charge, but not to

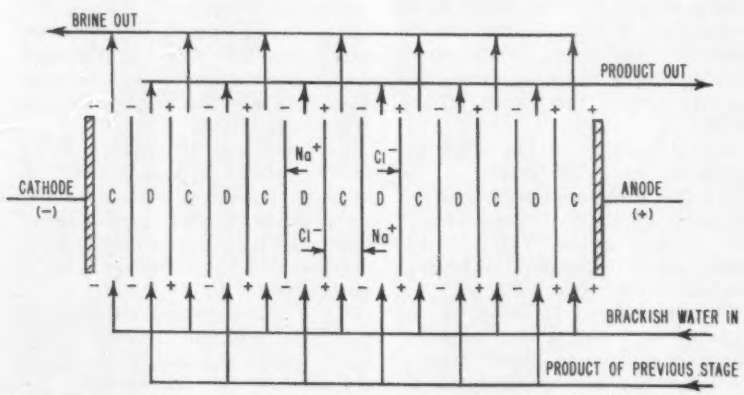


FIG. 1 shows the best electrodialysis method for conversion of brackish water. Flow is parallel to the plates.

Mr. Rapier is associate research engineer for the sea water conversion project, University of California.

ions bearing the opposite charge. Thus (Fig. 1), membranes that are permeable to anions are marked with a positive charge, while those that are permeable only to cations are marked with a negative charge. Furthermore, these membranes actually bear a net charge in solution corresponding to these signs, for reasons that will be given later on.

The dilute stream compartments, marked with the letter "D", are manifolded so as to be fed with brackish water through a single header; and they discharge into another header that conveys the demineralized water. The flow of water is adjusted to a speed of about 1-20 cm/sec, and occurs parallel to the plates.

In each of these compartments, cations such as Na^+, Ca^{++}, Mg^{++}, etc. migrate to the left, while anions such as Cl^-, SO_4^{--}, etc. migrate to the right, under the influence of the potential on the electrodes. The cations pass through the membrane on the left side of the dilute compartments and wind up in the adjacent concentrating cell. Similarly, the anions pass through the membrane on the right side of the diluting compartments and wind up in the adjacent concentrating cell.

As the ions in the concentrating cells continue to move toward their respective electrodes, they encounter a barrier at the next membrane, which bears the same sign of charge that they do. The like charge repels these ions, so that they cannot migrate through the small pores of the membrane. Hence, they are trapped effectively within the concentrating compartments, and are eventually removed in the brine effluent. In the end compartments, which are concentrating cells, the ions find no barrier between themselves and the electrodes. Here electrolysis takes place, with the formation of hydrogen at the cathode and oxygen and chlorine at the anode. These gases are customarily removed from solution in weathering tanks.

The process is most efficient when a large number of compartment pairs are used. Two hundred pairs per electrodialytic stack are not uncommon. In these, for every ion that electrolysis removes at the electrodes, there will be 199 removed in the brine stream. Employing enough membrane pairs can make energy losses due to electrolysis quite small. However, losses from polarization are more troublesome.

Polarization Effects

Polarization occurs adjacent to the membranes in the diluting compartments at a critical current density. In the so-called transfer film immediately adjacent to the membranes, it is possible, at high current densities, for ions to transfer through the membrane and into the adjoining concentrating compartments at a faster rate than they can arrive by electric transport and by diffusion.

Energy Requirements for Electrodialysis of Saline Waters

Solids content ppm	Power—kwh per 1,000 gal	Reference
1,800	8	7
3,000	14	8
5,000	22	8
8,000	35	7
8,800	9 (incomplete)	6
10,000	45	8
22,000	110	7
32,000	135	7

The depletion of electrolyte in this transfer film, together with a sharp increase in its electrical resistance, characterizes "polarization," in the sense that it is used here. The water becomes ionized, and a significant fraction of the current is carried by hydroxyl and hydrogen ions, since other ions are not available. Moreover, even the best permselective membranes are rather ineffective with regard to these two extremely mobile ions, with the result that both hydrogen and hydroxyl ions are able to migrate through the wrong membranes.

The increased resistance results in increased Joule heating losses, while conduction by hydrogen and hydroxyl ions generally lowers the current efficiency of the process for transferring electrolyte. Operating difficulties from changes in pH accompany polarization. At a high pH, calcium carbonate and magnesium hydroxide are formed in and on the membranes, and the accumulation of these scales rapidly chokes off the demineralizing process, forcing a shutdown.

A convenient way to combat this scale formation is to use separate electrode streams, which are neutralized with sulfuric acid at a nominal cost of 2-3c per 1,000 gal of water. This, in turn, will result in the precipitation of some calcium and barium sulfate scale, which can be removed by a combination of blow-down techniques and periodic reversal of the polarity of the electrodes.

Membranes Justify High Cost

Membrane films are available commercially from several sources, such as Ionics, Inc., American Machine Foundry, National Aluminate Corp., and Permutit Co. in America; Bronswerk N.V. in Holland; and several corporations in Japan. They cost about $12 per sq ft, but their indefinite life and the number of gallons of water produced justify the expense. So far, membranes have shown the most promise for conversion of brackish waters of up to 8,000 ppm salinity, as the energy requirements are substantially below those for vapor-compression and for multiple effect evaporation at these salinities.

Bronswerk estimates that the total cost, to produce a potable water of 300 ppm salinity from brackish water of 2,000-4,300 ppm salinity, should range between 45-65c per thousand gal produced, when quantities of 10 million tons of demineralized water are needed per year. Because of this favorable cost, industry can reevaluate isolated mining areas where the cost of water has previously been the major deterrent to development. If a local source of brackish water is available, such areas are now open for exploitation.

Two Kinds of Membrane

Membranes are designated as homogeneous or heterogeneous, depending upon whether they are constructed primarily of ion exchange resins, or of active granules that have been bonded together with an inert binder. Trend appears to be towards the homogeneous type, in which reinforcement with fabric net compensates for the poor mechanical strength inherent in the most active ion exchange materials.

This type of construction is under investigation now at the Sea Water Conversion Laboratories of the University of California. The membranes produced in Pretoria, South Africa, however, are simply a paper parchment, made by activating ordinary paper with suitable reagents of phenolic and amino character. Perhaps these can be classified as very efficient heterogeneous membranes.

The basis for all commercial membranes is styrene. To the benzene nucleus, active groups are attached to form the ion exchange monomer. Then this material is copolymerized with divinylbenzene, to yield a resinous film of the desired electrical and physical characteristics. Pore sizes ranging between 5 and 20 angstrom units are desirable for permselective membranes. The manner in which the resin is cross-linked with divinylbenzene controls this property to a large degree. The water content of the resin turns out to be a direct measure of the pore size. Many commercial resins have water contents close to 30%, indicating a mean pore dia of around 20 angstrom units.

When primary, secondary, or tertiary amino groups are employed to activate the resin, an anionic exchange

resin is formed. Conversely, when carboxylic, phenolic, or sulfonic groups are used for activation, a cationic exchange resin is formed. The permselective membranes bear a similar designation; thus, a membrane that is permeable only to cations is formed when sulfonic groups are used for activation.

Ion exchange resins are ionized to a high degree in solution. However, only the inorganic ion is free to migrate. The organic end of the molecule is cross-linked to a degree that makes the resinous matrix entirely insoluble in water; and it is this property alone that characterizes an ion exchange material. The nature of ion exchange is shown by the following equations, where R represents the insoluble, organic radical:

$$2R^{+}NO_3^{-} + SO_4^{--} = R_2^{+}SO_4^{--} + 2NO_3^{-}$$

$$R^{-}Na^{+} + K^{+} = R^{-}K^{+} + Na^{+}$$

The mobile ends of the ion exchangers are dissolved in the water that occupies the small pores of the resin. Any ions in the solution that possess the same sign of charge as the mobile radical are free to migrate through the resin. Thus, a cation exchanger is used to form a cationic permselective membrane, while an anion exchanger is used to form an anionic permselective membrane. Because one sign of charge is fixed in each of these, the cationic membrane bears a net negative charge, while the anionic membrane bears a net positive charge. The overall membranes, however, including the water content, are electrically neutral. In Fig. 1, it is the net charge of R alone that is shown opposite each membrane.

Developments Expected in Sea Water

The Sea Water Conversion Project of the University of California is attempting to revise the present economic limits of the electrodialytic process upwards from 8,000 ppm of salinity. Sea water normally contains 35,000 ppm salinity, and possesses enough hardness to cause scaling difficulties with most heat exchangers and evaporating equipment. Electrodialysis may offer a way around some of these difficulties.

More directly, electrodialysis is at present the only feasible sea-water conversion process whose theoretical energy requirements are proportional to the salinity of the water that is processed. For example, if vapor compression were used to treat a brine containing 15% salt, the energy requirements per unit of water produced would be virtually the same as for treating a brine containing only 0.2% salt. By contrast, the table shows the practical requirements for electrodialysis.

When these energy requirements are compared with those of other processes in the range of sea water concentrations, they are not too favorable now. In particular, the Joule heating losses are too high at high salinities, because of spacer geometry and the electrical resistivity of the now-available membranes; but these factors are improving constantly. Costs figured by this tabulation will soon be more favorable, according to indications.

The Sea Water Conversion Project recently installed a membrane stack, made by Ionics Inc., into a flexible system designed to evaluate electrodialytic procedures over the entire range of salinities anticipated for sea water conversion. The plant is completely automatic, to minimize operating costs. Controls on the panel are interlocked for safety. Also associated with this project are complete laboratory facilities for development and evaluation of electrodialytic materials and procedures, and for analysis of the demineralized water produced.

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Senegal Phosphate Gets Under Way

TEN YEARS after its discovery, and after extensive exploration-development operations, the 40-million ton phosphate ore body near Dakar, Senegal, Africa, is being mined by Compagnie Senegalaise des Phosphates de Taiba.

The phosphate-bearing matrix is covered by a sandy overburden, from 10 to 15 m thick, which differs from those occurring in Florida in that it does not contain coarse phosphate particles or pebbles. Taiba's phosphate particles vary in size from 2 mm to 0.03 mm, and as a consequence, thorough washing and dispersion of the clayey matrix is necessary to obtain optimum recovery. Other materials present in the matrix include quartzites, aluminum and iron oxides, and small amounts of limestone. The matrix proper is 6 to 8 m thick, and the mine-run ore averages 29% P_2O_5, or an equivalent of 63% tricalcium phosphate.

Both overburden and phosphate-bearing matrix are removed by large draglines. Mined matrix material undergoes a primary washing and screening process before being shipped to the 6,000-tpd processing plant. This is done in a plant unit mounted on pontoons containing a 3½x12-m revolving trommel. A vibrating screen with 2-mm openings and an auxiliary section with 20-mm openings remove the large flint and Silex stones. The plus-2-mm material, which constitutes from 5 to 10% of the plant feed, is barren, and as such is used for filling worked-out pit sections. Pond water can be used for washing operations but not for flotation. The minus-2-mm screened material is pumped by large centrifugal pumps on board the floating washing plant to the processing plant 1,000 m distant.

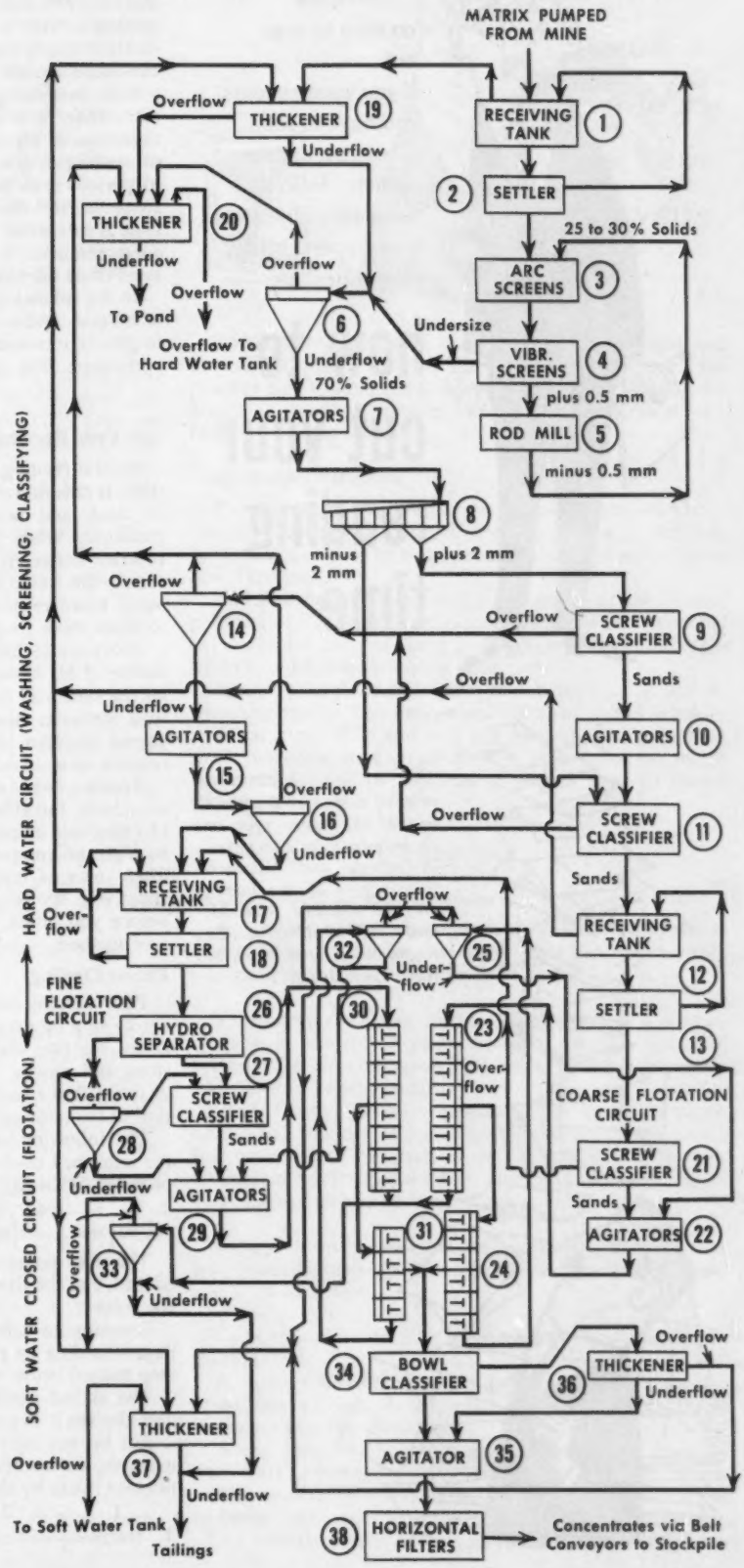
Except for separating 0.04-mm clayey slimes, processing plant operations closely follow those practiced in Florida mills. The slimes contain 27% P_2O_5 and constitute about 40% of the plant feed. Treatment involves secondary washing and screening of the pumped-in plant feed to produce a 0.5-mm product, grinding of the oversize from the secondary screens (4) to 0.5-mm in a rod mill (5), and flotation.

To reduce reagent consumption in conditioners, flotation is carried out in two separate sections: (1) coarse flotation, using feed in which particle sizes vary from 0.2 to 0.5 mm; and (2) fine flotation, using feed in which the particle sizes vary from 0.04 to 0.2 mm. A high-grade phosphate concentrate (38% P_2O_5) is produced by direct oleic acid flotation employing multi-stage cleaning without use of amine reagents. The fine-grained flota-

Flowsheet of 6,000-tpd Phosphate Plant, Campagnie Senegalaise des Phosphates de Tabia.

LEGEND

1. Two receiving tanks. Capacity 1000 m^3 each
2. Settler
3. Four arc screens, each 2.5 m^2
4. Four vibrating screens with 0.5 mm openings
5. 1800x3000-mm rod mill
6. Eight 700-mm hydrocyclones and 36 350-mm hydrocyclones
7. Four 1600-mm dia turbo agitators
8. Four chamber classifiers
9. 1500 mm dia by 8000 mm Simplex screw classifier
10. Three 1250-mm dia turbo agitators
11. 1500 mm dia by 8000 mm Simplex screw classifier
12. 1000-m^3 capacity receiving tank
13. Settler
14. Sixteen 350-mm hydrocyclones
15. Three 1600-mm dia turbo agitators
16. Ten 350-mm hydrocyclones
17. 1000-m^3 capacity receiving tank
18. Settler
19. 22-m thickener
20. 120-m thickener
21. 1500 mm dia by 8000 mm Simplex screw classifier
22. Four 1250-mm dia turbo agitators
23. Two airflow flotation machines (8 cells each)
24. Two Wedag flotation machines (6 cells each)
25. Two 350-mm hydrocyclones
26. 18-m dia hydroseparator
27. 1200-mm dia by 8000 mm Duplex screw classifier
28. Eight 200-mm hydrocyclones
29. Four 1250-mm dia turbo agitators
30. Four Airflow flotation machines (8 cells each)
31. Four Wedag flotation machines (4 cells each)
32. Two 200-mm hydrocyclones
33. Four 350-mm hydrocyclones
34. 5000-mm dia classifier bowl
35. 1600-mm dia turbo agitator
36. 12-m thickener
37. 60-m thickener
38. Four horizontal filters, each 12.5 m^2 filter area



tion concentrates are dewatered in special horizontal filters, each with a filter area of 12.5 m^2.

Regular ground or pond water, which is hard, can be used in washing and screening operations but not in flotation. As a consequence, both the fine-grained and coarse-grained flotation plant feeds produced in the secondary washing and screening section of the mill, after dewatering, are treated for about 2 min with a mixture of Tall oil, gas and caustic soda solution prior to actual flotation. The pH in the flotation section is held between 9 and 10. Dumped finished concentrates are treated in a rotary dryer to reduce moisture content to about 2% before shipment to European consumers.

You are
a busy executive
...you have
no time to read
but
if you want success
you have to read
...correspondence,
memos, notices,
business publications,
newspapers, books,
magazines, etc.

how to cut your reading time

This article is a direct reprint of a booklet devoted to one of the major problems of today's busy executive—in mining and elsewhere. Free copies of the booklet may be obtained from McGraw-Hill Publishing Co., Room 601, 330 W. 42nd St., New York 36, N.Y.

HOW MANY PEOPLE THESE DAYS don't know how to read? Very few, you'll say. Yet many businessmen are now using only 20% of their reading capacities. They are reading less than 250 words a minute—the average for businessmen generally. This is because they read word by word, at a rate not much faster than they can talk. Trained readers can attain speeds of 1,000 words per minute, and more.

Like swimming, reading is based on habits. The swimmer, when he is not practicing a particular stroke, is unconscious of his movements. Most people formed the habit of reading in grammar school, and have made little effort to perfect it to meet the demands of adult life. Like the swimmer, the reader needs to perfect his skill consciously if he is to survive in his personal sea of business literature, correspondence, newspapers, business publications, etc. He must trade his old bad habits for new good ones.

In the following pages, we will give you the fundamental techniques and a self-improvement program that can help to greatly increase your reading speed with improved comprehension. The rest is up to you!

SPEED

Cut Your Reading Time in Half

Skillful reading, like skillful swimming, gives you a head start. It cuts down backlogs of correspondence; it frees you to think and act—or frees time for other duties and pleasures. When you read faster, comprehend and concentrate better, you not only save time, but you also increase the value of your reading. You become a more alert, more responsive reader. You develop your ability to draw more intelligent conclusions from what you read.

Everyone in business and industry can benefit from an easing of his heavy load. You are probably already giving all the time you can to business reading, and find that the load increases about every day. Better reading habits—gained through simple practice methods—can *cut your reading time in half.*

Reading habits are firmly established in the early grades of school; therefore, it is going to take a certain amount of conscious effort to replace these habits with new ones. It might be compared to driving a hydromatic automobile after years of driving the standard shift. You would instinctively try to shift and it would take some practice before you could operate the car smoothly by using the new method.

Phrase Circling

Poor reading results mainly from the tendency of the eye to stop on every word. Your eyes do not simply sweep across the line when you read but progress in a series of stops and moves, seeing the words only when they stop or fixate. Your reading speed depends largely on the deviation of fixations you make on each line of print.

The following sentence illustrates the eye movements of the untrained reader (each number represents one fixation, or pause of the eye):

1	2	3	4	5	6	7	8	9	10	11	12	13
If	you	read	word	by	word,	you	spend	needless		time	and	energy.

The eye movements of the untrained reader are haphazard, and the slower he reads, the less his mind is held on the subject.

Learning to take bigger visual "bites" of the printed page—reading by phrases—is the first and most important step toward better reading.

The skilled reader fixates briefly once on every phrase and absorbs it as a unit.

For his eye movements are rhythmic and efficient. For example, he makes only four fixations compared to the thirteen made by the untrained reader.

1	2	3	4
If you read	word-by-word,	you spend needless	time and energy.

Phrase-reading not only increases speed, but it also improves comprehension and concentration by "keeping the mind busy." You can think much faster than you can read, since your mind naturally moves faster than your eye. If you read slowly, your mind is free to wander. But by reading faster, in phrases, your eyes provide your mind with more absorbing material. You do not have to stop after three or four fixations to assimilate an idea as you do in reading word-by-word. By reading in thought units, you are reading the same way you think, in concepts.

To build an awareness of phrases, try circling them on the printed page. For example, take a pencil and circle each of the meaningful thought units on the exercise paragraph that follows. Read it a second time, taking in each circled phrase. Ten minutes of daily practice will soon have you automatically seeing phrase groups instead of words.

EXERCISE

On the Job—The 10-years-after men aren't job-jumpers. Seventy per cent have had either one or two employers, including their present one, since graduation. Only four per cent have worked at five or more different jobs. Thirteen per cent are self-employed, and many of the others—especially of the 40% working for firms with fewer than 500 employees—work in family concerns.

Middle management men work hard at their jobs. They average 50 hours a week; 15% of them put in 60 hours. Much of their "non-working" time is taken up with business-related activity. Their magazine reading, for instance, is mostly trade or professional journals. In general, they get their deepest satisfaction from their families.

(From BUSINESS WEEK)

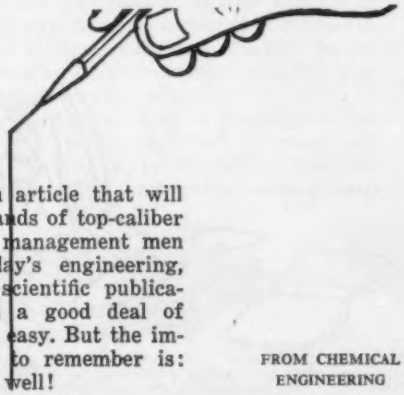
Space Reading

Space-reading—looking at the space just above the line of print, instead of directly at it—is the next step in developing rhythmic eye movements. Even after becoming aware of phrases, you may find it hard to read by phrases. This is because the white spaces between words naturally break the sentence into separate words. Your eye will still want to jump from word to word. By focusing on the space above the printed line, you will find your eye fixations will become smoother, and the phrases will hold together much better.

Once mastered, it will increase your reading speed and lessen the strain on your eyes.

Columnar Reading

You can also improve phrase-consciousness by letting your eyes move down a column of type with only one fixation per line. At first it will help you to draw a pencil line down the center of the column and to follow this with your eyes. Try to see the first and last words of each line of type while looking directly at the center. Sample:



To write an article that will interest thousands of top-caliber technical and management men who read today's engineering, business and scientific publications requires a good deal of effort. It isn't easy. But the important thing to remember is: You can write well!

FROM CHEMICAL ENGINEERING

To start, you may find it easier to try the second and next-to-last words of each line of type. Later you may practice this technique on the way to work or during any breaks in the work routine. You will find it helps greatly to increase your eye span.

Variable-Speed Reading

This technique will intrigue you. As we're sure you know, you do not read all material at the same speed. You can handle light reading at high speed. Technical material slows down any man.

Variable-speed reading makes it possible to get a broad picture fast . . . to go right through the **bold-face type** and get the whole train of thought. If you want only the highlights you don't have to slow your pace.

However, you can shift gears as you read . . . if you do want the details. You can go rapidly through the article—with assurance that you will not miss any main point—until you come to a signal about a main point on which you want detail. You can then slow your pace to absorb the detail. Try this:

EXERCISE

Refinery Sleuth Traces Arsonists

A gas chromatograph—commonly used in refineries to detect different gases in a mixture—now can help identify materials used by arsonists to start fires.

The instrument works on the principle that, if a mixture of gases is allowed to flow through a specially prepared column, the different gases will travel at different speeds and can thus be separated.

W. J. Cadman, chief criminologist for Orange County, Calif., and Therom Johns, research chemist for Beckman Instruments Inc., designers of the chromatograph, say this instrument with supersensitive probing powers figures in every case of suspected arson in the country.

In 90% of arson cases, the fire is ignited by gasoline. The gas chromatograph is able to identify the gasoline by brand and even by grade.

Cadman and Johns give an example of how the instrument is used:

A factory was damaged by fire, and police suspected arson. An extract of the ashes showed gasoline traces where no gasoline should be.

A can partially filled with gasoline was found near the fire's starting point.

The chromatograph matched the contents of the can, as to brand and grade, with the mixture that started the fire.

An attendant at a nearby service station identified the

container. He also identified the customer who had borrowed it. The scientific detection helped obtain a conviction.

The instrument is said to provide a major breakthrough in arson detection.

(From PETROLEUM WEEK)

Indenting

Also helpful is indenting—or not allowing your eyes to read either end of a printed line. When moving down from one line to the next, break away about ⅛ in. in on the next line. Normally your eye automatically pulls to the white margin on either side. Of course, this slows down your reading speed considerably.

Self Pacing

Get in the habit of constantly improving your reading rate by pressing against the very limits of your current capacity for a few minutes every day. Time yourself every now and then to see how you are progressing.

COMPREHENSION

Benefits of Pre-Reading

Before pre-reading each article, you may think that this process wastes time rather than conserves it. Before long, however, prereading (with a little practice) becomes automatic, takes only a minute or two, and you will find that you will:

Save time. Not every article is of equal importance to you. A pre-reading will tell you whether you will profit by a thorough reading of the article at hand. It will tell you if the article is on a subject that will interest you. (Titles and brief descriptions can sometimes be misleading.) It will tell you if the discussion is too elementary and simply repeats what you already know. Or it will tell you if it is too advanced, if you must get a better background before you tackle the article or book at hand. If a pre-reading indicates that the article deserves a thorough reading then you have also saved time by your preliminary survey. Your advanced sampling of the author's style, your fore-knowledge of the major points to be covered and the conclusions to be drawn, all help you to get through the article more quickly.

How to Pre-Read

To pre-read an article, read the overview or summary of the main points. If the article appears useful, read the first two or three paragraphs, which are most always sure to introduce the subject in a general way. Then continue reading only the first sentences of each paragraph. Be sure to note subheadings, diagrams, charts and pictures as you go along. The author will generally summarize his arguments in the last two or three paragraphs; read them thoroughly. If after pre-reading, you feel a thorough reading is justified, you are ready to read intelligently and critically, since you already have an idea of what the author is talking about.

Summarizing and Critical Reading

Merely understanding what you read is not sufficient; you must evaluate it as well.

Summarizing is an invaluable technique to help comprehension and retention. To collect unrelated facts of varying importance is of no value to you. Therefore, summarizing will help you to organize these facts in order of importance. As you acquire the skill you will be able to summarize mentally; but to start, it will be better to write down your summary.

As you read an article, clearly distinguish between main ideas and details. The topic sentence will usually give you the main point of the paragraph and the details will follow in the middle and latter part of the article. Jot down the main idea or topic sentence as you read and place the relevant points in order beneath it. This is a simple 1, 2, 3—a, b, c pattern. Upon finishing, you will have an introduction statement, the main points that are to be retained, and a summary statement. This will provide you with a framework into which more detailed facts can be fitted and thus easily retained.

Environment

In all your reading, make sure you have a good environment, free from poor lighting and undue distractions. For example, always read in a well-lit room with at least two lights of equal intensity to prevent glare. And remember that excessive comfort will hinder, rather than increase your ability to concentrate.

It is vital to your career that you read with the same professional authority you exercise in all other phases of your job. Not only because it saves time for you. It also pays a bonus in new productive time. How? Because a man's mind moves far faster than he can read. Thus, as your eyes race to catch up with your brain suddenly you have more time to think. And you think more lucidly. You concentrate easier. Plan more decisively. Move with new confidence. Inspire and impress others.

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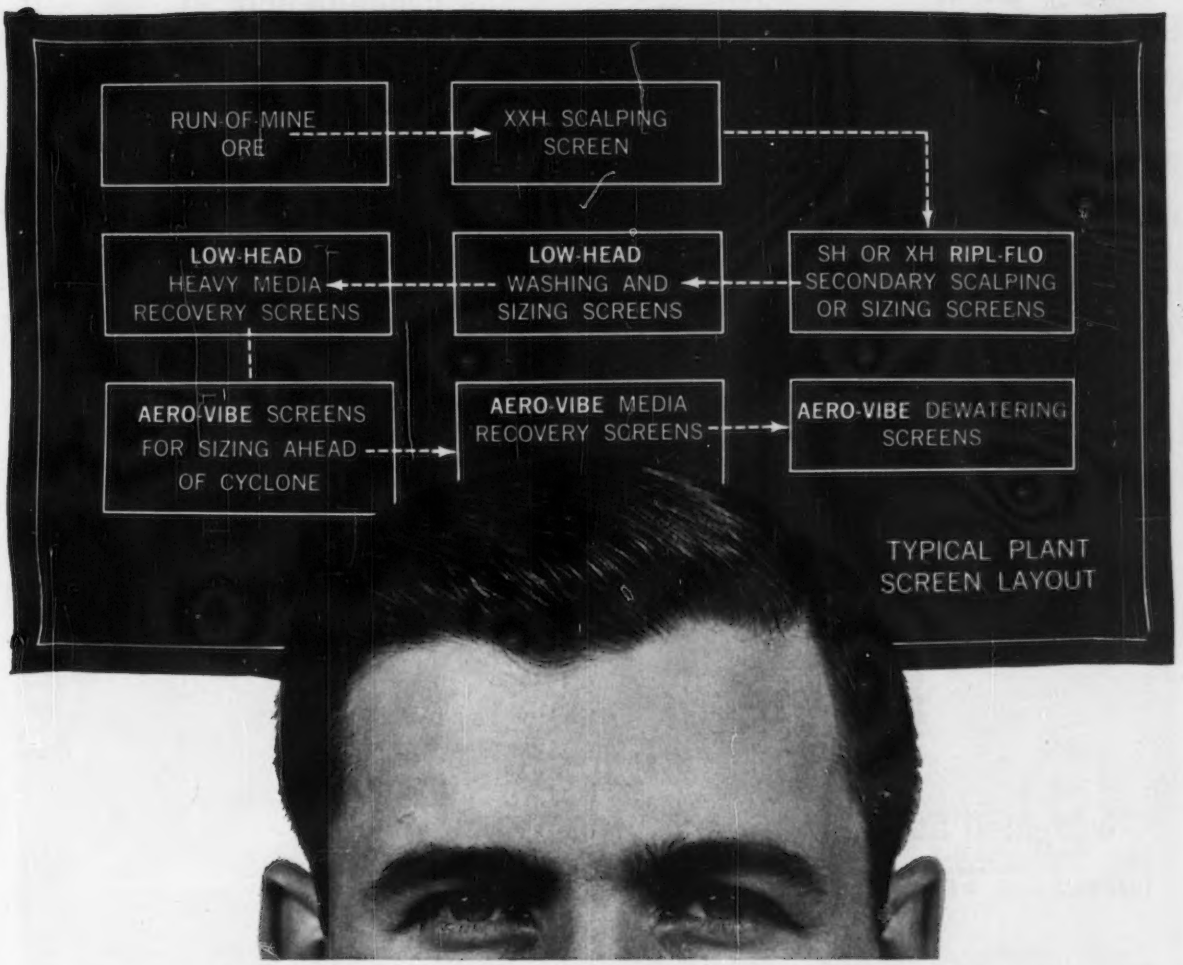
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Ask your A-C representative about the specific features that make A-C screens a dependable part of your system. Or write **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1370

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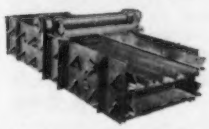
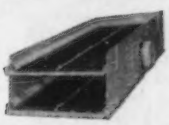


For media drain and dewatering in cyclone plants — AVS **Aero-Vibe** inclined screen.

Coarse to fine sizing (wet or dry), rinsing, washing, dewatering and media recovery — **Low-Head** horizontal screen saves headroom too.

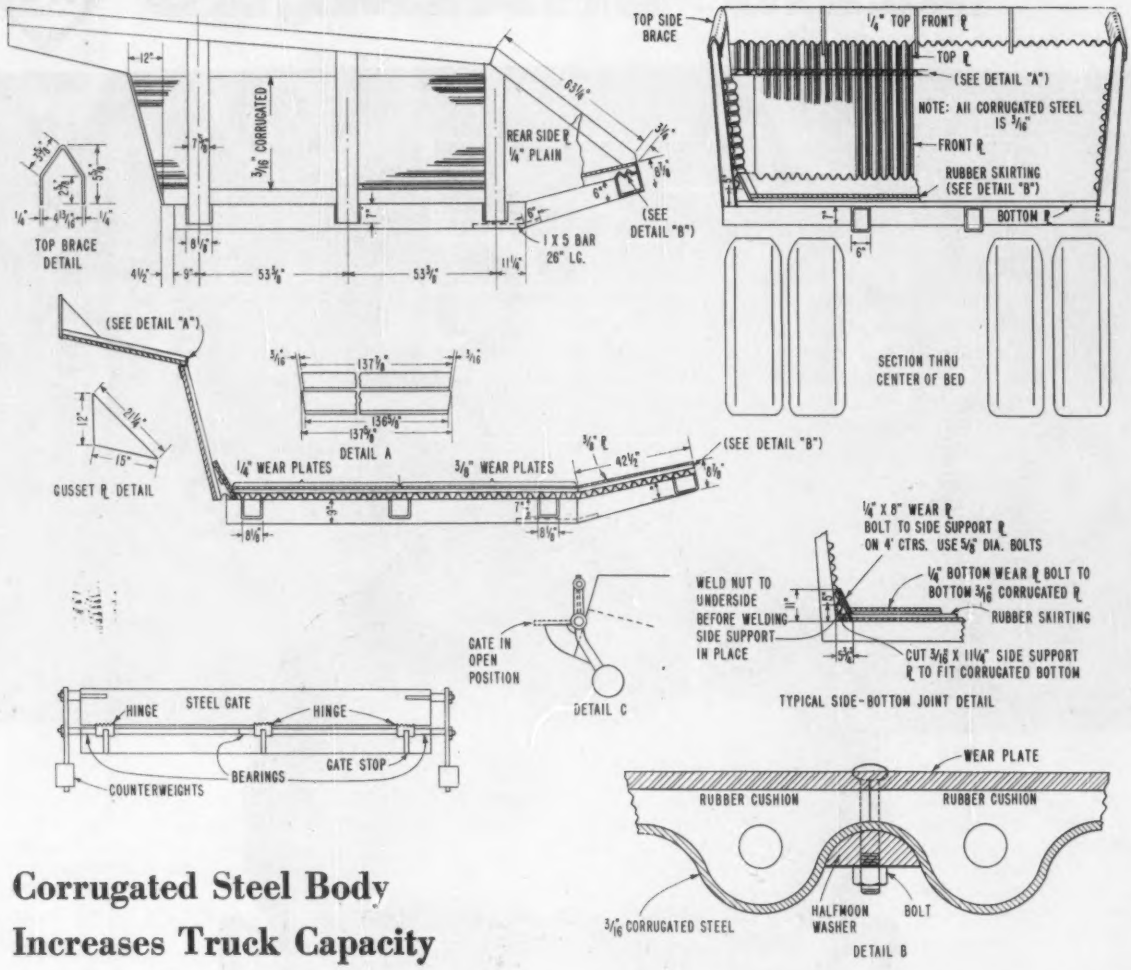
For scalping and coarse sizing, wet or dry — XH **Ripl-Flo** rugged cost saving inclined screen.



For light scalping, coarse or fine sizing (wet or dry) rinsing or washing — SH **Ripl-Flo** inclined screen.

For tough primary scalping jobs and high tonnage — XXH **ROM** inclined screen.

OPERATING IDEAS



Corrugated Steel Body Increases Truck Capacity

A HIGHER PAYLOAD and improved truck operation in general have been obtained at the large open pit copper mine of Anaconda Co. at Weed Heights, Nev., by evolving the novel truck body or bed shown for use on the diesel-powered Dart Model 140 trucks serving the ore and waste haulage systems.

The truck body was designed by the company's engineering staff. An innovation is the use of 3/16-in. corrugated steel in its construction. The plate units required for the walls and bottom were prefabricated and properly corrugated by Ryerson Steel Co. and final assembly and welding of the body proper were done at the company garage under the direction of M. G. McGollum, department head of maintenance.

Use of properly corrugated steel has enabled the designers to construct a stronger, wider and lighter truck body, thereby reducing the overall weight and increasing the payload. Specifically, weight of the truck has been reduced four tons and the payload upped from the original 20 yd to 27 yd.

Another interesting design feature, one that has materially lengthened the life of the wear plates covering the body floor, is the rubber-cushioned-body bottom. Special rubber skirting is installed between the corrugated-body bottom proper and the wear-plate assembly.

The assembly is made from steel wear plates, ¼ in. thick at the front end and ⅜ in. thick in the center and dump end of the body. Plates and rubber skirting are held securely to the body bottom by bolts with halfmoon washers, as shown in Detail B. The ⅛ in. play between the wings of the rubber skirt or cushion and the upper ends of the corrugations supplies compression to the section of the skirt embedded in the corrugation proper.

The truck body described has only been in service for a period of three months and has hauled about 150,000 tons. It is too early at this time to make a definite statement regarding the structural strength of this locally designed unit. However, from all appearences to date, this type body has all the inherent strength and is equal to or greater than standard design.

A further check, four to six months from now, will give definite answer as to whether or not this type body will stand up as well or better than the conventional design. If such is the case, then industry should use corrugated steel, which decreases the tare weight and permits increased payload.

To prevent spillage when the loaded truck travels up a 7 or 8% grade, the dump end of the truck body has been equipped with a counterweighted tail gate explained in Detail C. The gate is 6 in. high and made from ½-in steel plate. Parts making up the gate assembly include the gate proper, three bearings, three hinges to which the gate is welded, three gate stops, shaft, and counterweight arrangements at both ends of the steel tail gate.

Operation is simple and positive. The tail gate automatically opens when the truck body is raised to dump position and held in place by the gate stops and counterweights while the load flows freely over it. When the truck body is lowered, the counterweights drop, thereby closing the gate.

E&MJ expresses its thanks to A. E. Millar, general manager, for permission to publish this article.

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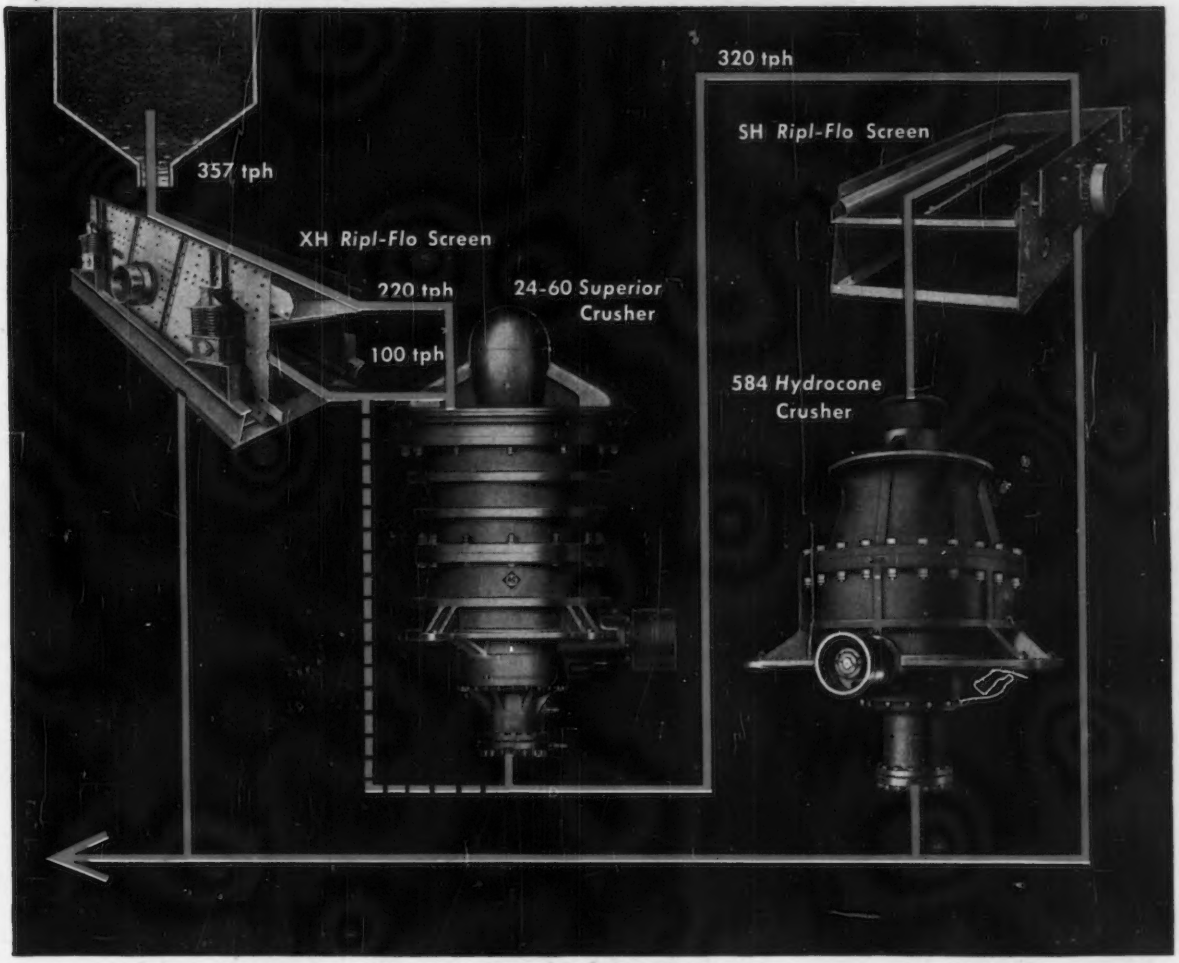

King-size crushing job—from 16" feed to ¾" product—with

two crushers instead of three

Two important efficiency factors were the key to a new installation in Southwest "copper country."

First of all, only Allis-Chalmers could furnish the right-sized crushers to do the job. A 24-60 *Superior* gyratory is the primary crusher for reducing raw 16" ore down to 2½". Final crushing, down to ¾", calls for a 584 fine chamber *Hydrocone* crusher. It's normally a job for three crushers — but these two do the job dependably . . . and both are equipped with time-saving *Hydroset* controls.

Secondly, A-C engineering service specializes in designing plant flows that bring out the best in equipment . . . designed for maximum efficiency, step by step, from bin to storage pile.

Ask your A-C representative about complete engineering service and the size range of A-C crushers. Or write **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1335

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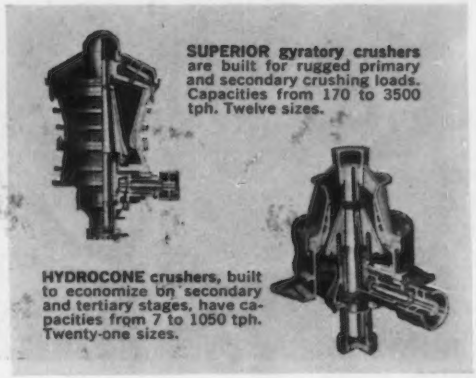
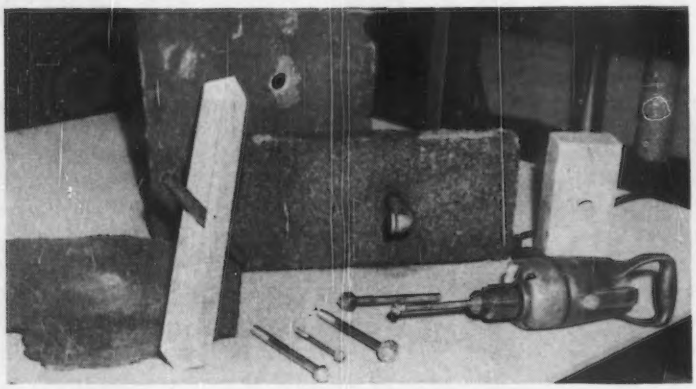

SUPERIOR gyratory crushers are built for rugged primary and secondary crushing loads. Capacities from 170 to 3500 tph. Twelve sizes.
HYDROCONE crushers, built to economize on secondary and tertiary stages, have capacities from 7 to 1050 tph. Twenty-one sizes.



Compound Permits Simple Fabrication of Drills and Bits

A RESILIENT, tough compound, tradenamed Certanium Carbidrill 21, can be easily and economically applied to metal to form "home-made" bits and drills.

The new material, a product of Certanium Alloys and Research Corp., Cleveland, Ohio, is cast in welding rods composed of 70% abrasive (crushed tungsten carbide segments with 6% cobalt), and 30% matrix alloy (Ni, Zn, and Cu).

A test 36 in. core drill, made by applying a single rod of the compound to four short segments of a 35 in. pipe, cost a foundation company less than $10.00, and made 200 six-ft.-deep holes in chalkstone.

After first tinning the chosen metal surface with a matrix-alloy preparation, the material is applied by brazing, using a special flux which prevents fuming and promotes wetting.

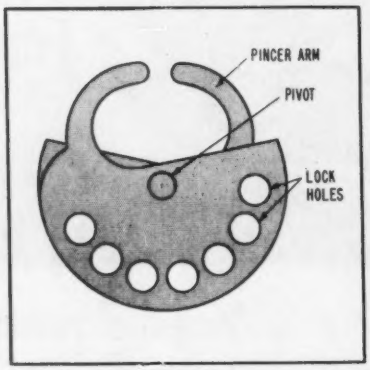
According to the manufacturer, Carbidrill 21 is particularly well suited to field fabrication of drills and corers, since no furnace, mould, or special skills are needed. Drills may be made by laying on a small deposit of the compound to a bolt head or shaft. Core drills can be improvised with a few pennies' worth applied to a piece of pipe.

The strength of the resultant drilling surface is attributed to an inseparable bond between matrix-alloy and carbide elements. This enables the tool surface to withstand strong shock without loss of cutting particles.

Simple Lock Plate Gives Electric Switch Security

THE RECURRING problem of electrical switch protection, where hazard exists to personnel working on lines in remote mine areas, has been met by a lock-plate device described by Lindsey Hoben of Oak Ridge, Tenn. The device, termed a "multiple lockout" by Hoben, is, essentially, a pincers which may be fitted to hasps of varying sizes and padlocked shut.

Simple in design, two backing plates of 3/16 in. stainless steel are center pivoted, and are pierced with holes which may be aligned at seven pincer aperture sizes. Thus, the lockout is adaptable to switch box covers, transformer housings or cages, explosive magazines, barricaded areas and vaults, affording greater security than by the use, solely, of signs and tags.



Raise Ladder Made From Scrap

HARRY A. LEAVITT, assistant mine manager with North Rankin Nickel Mines, Ltd., Fort Churchill, Manitoba, has devised a flexible and easily portable raise ladder, using cable, clamps. and scrap pipe and hose. The ends of a 40 ft length of 3/8 in. cable are threaded alternately through holes drilled in pinched ends of 14 in. rungs of ½ in. pipe and 14 in. lengths of ½ in. water hose, which form spacers for the rungs. The cable ends are clamped to form a loop to hang on a raise pin.

Leavitt has used standard ladder dimensions of 14 in. for both his rungs and spaces. The hose protects miners hands from wire snags, and provides resiliency which saves wear on the pipe rungs.

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NEW BOOKS

Introduction to Solids, by Leonid V. Azaroff, associate professor of metallurgical engineering, Illinois Institute of Technology. This subject should be of special interest to mining engineers for two reasons: (1) Because the science of solid-state physics came into being after most of the present engineers had an opportunity to learn about it. It is this science that has produced the transistor and the tunnel diode and many other devices in the semiconductor field which will do more to revolutionize the field of heating, cooling, communications and electronics than any other invention of the century. (2) The book is based on the principle that the majority of solids of practical importance have this in common—they are crystalline. Although the importance of crystallography has long been recognized, this book treats the crystallography of solids as a framework for discussion of their nature and properties. The text is as modern as its photographs of marcasite and pyrite, magnified slightly over 5-million times. It is actually possible to see the arrangement of the iron and sulphur atoms in orderly lattice formation in these photos. Chapter headings are as follows: Geometrical crystallography, the structure of crystals, atomic packing of crystals, imperfections in atomic packings, mechanical properties of crystals, formation of crystals, transformation of crystals, the bonding of atoms, properties of metals, structure of metals, properties of semiconductors, structure of semiconductors, properties of insulators, structure of insulators. The author resorts to a minimum of mathematical expressions to illustrate principles, and then only with equations of an elementary type—i.e. no triple integrals.

The chapter on metals is especially significant. The free-electron theory, for instance, explains why metals are opaque, and why they reflect light (i.e., have metallic luster). This theory, on the other hand, does not explain discrepancies between observed and predicted specific heat of metals, nor does it explain why some substances are conductors of electricity and others are not. The copper and aluminum industries might be profoundly affected if scientists get to the bottom of these problems and synthesize or substitute other materials for electrical heating and cooling equipment. Other subjects covered in the chapter on metals include electrical properties, magnetic properties and thermal properties. The understanding of these properties is vital to the geophysicist, the metallurgist and the metal producer who wants to develop markets for his products. Published by McGraw-Hill Book Co. Inc., 330 W. 42 St., New York 36, N. Y. Pp 460. Price $9.50.

The Geology of Tongariro Subdivision, by D. R. Gregg, New Zealand Geological Survey. This report illustrates and discusses extensive volcanic action in the 635-sq mile area in the center of North Island. Published by the New Zealand Geological Survey. Pp 152 plus maps. Price £2, paper cover.

Ontario's Mineral Heritage. Designed primarily for school purposes, this booklet gives an excellent profile of Ontario's mining industry. Single copies available at no charge at the Ontario Department of Mines, Toronto, Ontario, Canada. Pp 28, including three mineral maps.

List of Publications of the Ontario Department of Mines, Revised to April 1960. Published as Bulletin No. 25 by the Ontario Department of Mines, Toronto, Ontario, Canada. Pp 71 plus 5 maps and a list of maps still available.

Land for the Future, by Marion Clawson, R. Burnell Held and Charles Stoddard. The basic concern of the authors, all of whom are Resources for the Future staff members, is the conflict between the demands of an expanding economy and a fixed area of land. The authors have analyzed the historical background, the present pattern of use, and the prospects up to the year 2000. Published by the Johns Hopkins Press, Baltimore 18, Md. Pp 500 including charts and tables. Price $8.50.

BOOKS presented on this page may be obtained directly from the publisher mentioned in each case. E&MJ does not sell books.

Zirconium Data File. Numerous charts, pictures, tables and graphs are included in this handbook on zirconium. Subjects include production of zirconium and hafnium, definitions, zirconium ingots, wrought products, zirconium alloys, properties, fabrication, forming, punching, extruding, drawing, electroplating, powder metallurgy, machining, welding, zirconium chemicals, hafnium, and other topics. Copies are available at Zirconium Information Center, Carborundum Metals Co., Akron, N.Y.

Foreign Trade Trends, Iron and Steel, 1960 Edition. Charts and tables include world reserves of iron ore, world production of iron ore, exports and imports of steel mill products, exports and imports of iron ore, foreign trade in pig iron, imports of manganese ore, and many other statistics related to the iron and steel industry. Published by the Committee on Foreign Relations, American Iron & Steel Institute, 150 E. 42 St., New York 17, N.Y. Pp 72. Price 50¢.

Mine Ventilation. Edited by A. Roberts. Authors are H. J. Bunt, J. R. Metcalf, B. R. Pursall, A. Roberts and F. T. Williams. Contents include chapters on the flow of fluids, determination of pressure, determination of air velocity and volume, mine gases, ventilation of mine wastes, mine climate, thermodynamics of mine ventilation, theory of mine fans, main fans, booster and auxiliary fans, ventilation surveys, ventilation planning and ventilation networks. Published by Cleaver-Hume Press Ltd., 31 Wright's Lane, Kensington, London W.8, England, Pp 363. Price 70s.

Research in Air and Water Pollution. This review illustrates and discusses the devices and techniques used in research underway today at New York University, College of Engineering, University Heights, New York 53, N.Y. Pp16.

The following publications of the U. S. Geological Survey can be obtained from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., for the prices specified:

Geology and Quicksilver Deposits of the Terlingua District, Texas. Professional Paper 312, by Robert Yates and George Thompson. This quicksilver district, in the southern part of the Big Bend region of southwestern Texas, has produced more than 150,000 flasks of quicksilver. Pp 114 plus 22 plates and 25 figures. Price $4.

Surficial Geology of Anchorage and Vicinity, Alaska. Bulletin 1093 by Robert Miller and Ernest Dobrovolny. Mineral resources in this area are mainly coal and nonmetallics, although some lode and placer deposits have been worked in the past. Pp 128 plus 10 plates and 7 figures. Price $2.25.

Geology and Thorium Deposits of the Wet Mountains, Colorado, a Progress Report. Bulletin 1072-H by R. A. Christman, M. R. Brock, R. C. Pearson and Q. D. Singewald. The report concludes that many of the localities in this area containing radioactive materials will be worth prospecting when and if the demand and the price for thorium justify an intensive search for new sources of supply. Pp 44 plus 2 plates and 3 figures. Price $1.

Spectrophotometric Determinations of Traces of Lead in Igneous Rocks. Bulletin 1084-F by C. E. Thompson and H. M. Nakagawa. Pp 13 plus 6 figures. Price 15¢.

The Development of Botanical Methods of Prospecting for Uranium on the Colorado Plateau. Bulletin 1085-A by Helen Cannon. One of the interesting discoveries noted by the author is that "Tree analyses may be used effectively to outline mineralized ground to a maximum depth of about 70 ft," also that "in most of the areas prospected, amounts of 1 ppm uranium or more in tree foliage are indicative of mineralized ground." One specimen *Astragalus pattersoni* contained 46,100 ppm of selenium, or a concentration of 4.6%, by botanical processes. This effective indicator plant is able to concentrate enormous quantities of selenium in the presence of carnotite. Pp 50 plus two maps, one showing generalized geology of a part of the Colorado Plateau, and a second showing distribution of principle types of vegetation in the same area.

Uranium Content of Ground and Surface Waters in a Part of the Central Great Plains. Bulletin 1087-G by E. R. Landis. Pp 60 plus 1 plate and 1 figure. Price 50¢.

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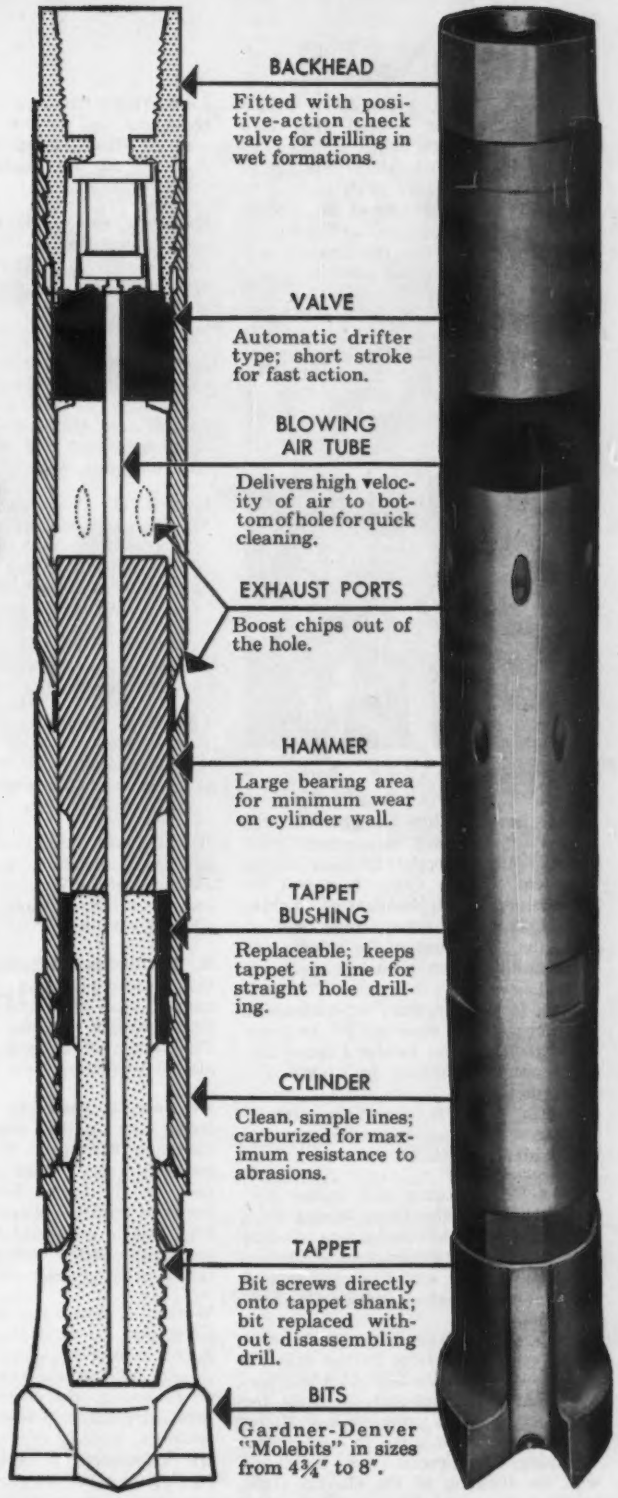
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PERSONALS

Charles A. Mitke, president of Minila Mining Corp. and veteran "Far East hand," visited Mt. Isa Mines at the annual meeting of the Australian Institute of Mining & Metallurgy in late summer. Mr. Mitke, first manager of Mt. Isa, 30 years ago, was described as having arrived at the site "after the dinosaur left, and before the kangaroo came in."

Albert B. Williams, formerly unit superintendent of Asarco's Santa Barbara unit in Chihuahua, Mexico, has been appointed vice president and general manager of the Northern Peru Mining Corp., a subsidiary of American Smelting & Refining Co.

Gough

Burt

Wayne Burt and **Ray Gough** have been named to important management positions at Utah Copper Division of the Kennecott Copper Corp. Burt will become general superintendent of smelting and refining operations; Gough will assume the same position for mining and concentrating. Both positions are newly created.

Burt, formerly refinery superintendent, has been with the company for 14 years. He started with the Braden Copper Co., a Kennecott subsidiary in Chile, as a mine foreman.

Gough, formerly operations superintendent at the mine, joined Kennecott as a trackman in 1950.

Charles A. McKinley was named general manager of the Trout Mining Co.'s silver-lead-zinc and manganese dioxide mining and milling operations at Philipsburg, Mont. He was formerly general manager of the Sidney Mining Co., Kellogg, Ida.

Jack Turnipseed, bridge builder with the American Bridge division of U.S. Steel Corp., has been selected to direct the construction of a multi-million dollar iron ore reduction plant in west-central Wyoming. Turnipseed was associated with the building of the Golden Gate, Oakland Bay and George Washington bridges.

Dr. H. P. Leighly, Jr., is now associate professor of metallurgical engineering at the Missouri School of Mines and Metallurgy. He was formerly research metallurgist at Denver Research Institute and head of instruction of metallurgy at the University of Denver.

John Davies has been appointed to the geological staff of the Ontario Department of Mines. He will serve as resident geologist in the department's Kenora office.

Howard Evans and **M. F. Williams** have been named to new positions at Columbia-Geneva Steel. Evans will be general supervisor of mineral processing and Williams will be manager of the raw materials research laboratory.

Jack Parker, formerly instructor of geology at Michigan College of Mining and Technology, is now with R. L. Loofbourow Co., Minneapolis, as consultant in underground site testing, planning, estimating and water problems.

Gordon H. Chambers has announced his resignation as chairman of the board of Foote Mineral Co. With Foote since 1928, Chambers is also a onetime president of the company. He will continue to serve on the board of directors.

State Rep. Marlin T. Kurtz of Cody was elected president of the Wyoming Development Association.

Charles A. McKinley has been named general manager of Trout Mining Co. operations at Philipsburg, Mont. He was manager for 14 years of the Sidney Mining Co., Kellogg, Ida.

A. J. Teske, secretary of the Idaho Mining Association, has been named chairman of the Western Governors Minerals Advisory Council. He succeeds Clark L. Wilson.

R. W. Beamer, executive secretary of the Wyoming Mining Association, was named vice chairman of the group. Frank Knight, director of the Arizona Department of Natural Resources, was elected secretary.

Dr. John J. Reed and **Dr. George V. Keller** are newly appointed to the Colorado School of Mines. Dr. Reed, formerly head mine research engineer for St. Joseph Lead Co., is professor of mining engineering. Dr. Keller, who was a geophysicist with the U.S. Geological Survey, will be assistant professor of geophysics and physics.

William B. Agocs has left Aero Service Corp. for independent consulting work in the natural resources field. He is an expert with worldwide experience in programming, the writing of specifications, supervision of natural resources inventories, training of personnel in modern techniques of exploration, evaluation of all types of geophysical surveys associated with minerals and petroleum.

Albert A. Guffey has been named supervisor of chemical development at International Minerals & Chemical Corporation's experiment station at Mulberry, Fla. A 10-year veteran with IMC, Mr. Guffey was production superintendent at the Bonnie, Fla., phosphate chemicals plant before his transfer.

Roy Jure has been named manager, exploration department, American Metal Climax Inc. He succeeds **Jack A. James,** who resigned to engage in private geological consulting work at 211 Bellair Road, Ridgewood, N. J.

Adrian C. Dorenfeld has joined the staff of the University of Minnesota's School of Mines and Metallurgy as associate professor. His field is mine and mill plant engineering.

H. B. James has been elected a director and president of Consolidated Purchasing and Designing Inc.

Felix E. Wormser was elected a director of Kennametal Co.

Dr. Robert A. Gross has been appointed professor of engineering science in mechanical engineering at Columbia University.

G. H. Bryant, superintendent of the Riverton uranium mill for Susquehanna-Western, was transferred to Denver as manager of the company's metallurgical division. **Richard E. Shreve,** formerly with the Gunnison Mining Co., will succeed Bryant at the Riverton mill.

Dr. George A. Kiersch, for the past nve years director of the geological mapping and resources survey for Southern Pacific Co., has joined the faculty of Cornell University. He replaces Prof. **C. M. Nevin,** who has retired to teach courses in structural and engineering geology.

Dr. Harold W. Paxton, associate professor of metallurgical engineering at Carnegie Institute of Technology, has received the $2,000 Bradley Stoughton Award of the American Society for Metals, which is given to outstanding young teachers of metallurgy.

Paxton

Brackin

Robert B. Brackin has been appointed manager for the Columbium Properties of the Kennecott Copper Corp. He will be responsible for Tin and Associated Minerals, Ltd. in Nigeria and Quebec Columbium Ltd. at Oka, Quebec.

Hubert Abramson, Calumet & Hecla Co., has been named mine captain at the Ahmeek No. 4 copper mine.

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PERSONALS *(Continued)*

Dr. Marion D. Barnes has been appointed industrial research director of the Sulphur Institute, Washington, D.C. He will have the responsibility of planning, initiating and pursuing research projects in the industrial field.

Vincent D. Perry, vice president and chief geologist of Anaconda Co., has been named by the Society of Mining Engineers as the recipient of its Jackling Award and as Jackling Lecturer for 1961.

Perry

Perry, who has been with Anaconda for 35 years, is a director of the company as well as the Green Cananea Copper Co., Golden Reward Mining Co. and Santiago Mining Co. He has been closely associated with the Yerington open pit copper mine in Nevada, the Grants uranium operation in New Mexico, the Berkeley pit at Butte, the El Salvador copper mine in Chile, the Nakina iron ore deposit in Ontario and the Bathurst zinc deposit of New Brunswick.

Ernesto L. Ahnert is mining engineer for San Francisco Mines of Mexico, Ltd, Chihuahua, Mexico.

George B. McMeans, vice-president of Kaiser Steel Corp., is being assigned to a new executive position as vice-president of Kaiser Industries Corp. and of Henry J. Kaiser Co.

Dr. Hughes M. Zenor, former chairman of the geophysics department at Tulsa University, is now professor of geophysics at the Missouri School of Mines. Appointed to a post at the same school was Dr. Arthur H. Brownlow, a recent graduate of M.I.T. Dr. Brownlow's field is geochemistry. He will be assistant professor.

Ray Jenkins, consultant in mining and construction, has joined the staff of the Ralph M. Parsons Co. in Los Angeles.

Dr. John B. Clark, research engineer at the Dow Chemical Co. in Midland, Mich., and **Dr. Frederick N. Rhines,** professor of metallurgy at the University of Florida, will share the Henry Marion Howe Medal, the oldest honor award given out by the American Society for Metals.

Prof. Frank A. Forward, head of the department of metallurgy at the University of British Columbia, has received a $1,000 John Scott Award of the City of Philadelphia for his invention of the Forward Process for extracting nickel and other metals from ore concentrates by ammonia and water under pressure. Among past recipients of the Scott Award were: Marie Curie, Orville Wright and Gugliemo Marconi.

Dr. Bruce Chalmers, Harvard University professor, was given the Albert Sauveur Achievement Award by the American Society for Metals "for pioneering achievement effecting marked basic advance in metallurgical knowledge."

John B. Johnson was named Gold Medalist of the American Society for Metals. He is considered one of the nation's leading experts on light metals. Retired as technical director of the Aeronautical Research Laboratory at the Wright-Patterson Air Force Base, he is now a consultant in his field.

Dr. Champion H. Mathewson, professor emeritus of metallurgy and metallography at Yale University, has been awarded the newly established Albert Easton White Award by the American Society for Metals. He received the award for his "singular ability to inspire students and impart enthusiasm and understanding, and for his metallurgical achievements."

Robert Archibald, executive vice-president, North Range Mining Co., has been elected a director of Upper Midwest Research and Development Council which, together with the University of Minnesota, sponsors an Upper Midwest economic study.

Dr. William R. Opie has joined American Metal Climax Inc. as manager of research of the Amco Research and Development Co.

Dr. Opie, who received his Ph.D. degree from Massachusetts Institute of Technology, will direct all Amax copper, lead and zinc research.

O. G. Seymour of Iron River, Mich., formerly a geologist with the M. A. Hanna Co., is now with the Marcona Mining Co. as chief geologist, succeeding Ernest E. Thurlow.

Maurice F. Dufour has been appointed director of research and development for Freeport Sulphur Co. He will be responsible for all of Freeport's operations and new enterprises.

Dufour

Dufour is a vice president of the company. He is also executive vice president and director of the Freeport Nickel Co., a Freeport subsidiary whose nickel-cobalt mining and concentrating facilities in Cuba were seized last August by the Cuban Government.

Harry B. Knowlton, retired International Harvester Co. engineer, was named William Hunt Eisenman Award winner by the American Society for Metals. This is a new award created to honor engineering achievement.

Clarence H. Sleeman has joined Koppers Co., Inc. as chief mining engineer for the foreign department in the engineering and construction division. He will work primarily on the development of the El Algarrobo iron ore deposit of Compania del Acero del Pacifico, S.A., in Chile. Sleeman was formerly with Jones & Laughlin Steel Corp. as chief mining and development engineer for the ore mines and quarries division.

Bernard Allen Bramson has accepted appointment by the United Nations as deputy project manager of its mining mission to Chile. Bramson, whose last foreign assignment was at Johannesburg, where he served the State Department as regional minerals officer for Southern Africa, has spent over 30 years in mining and metallurgical work in various parts of the world, principally Latin America.

OBITUARIES

Robert Y. Jensen, 39, assistant chief engineer of the M. A. Hanna Co., was killed in an airplane accident on October 9 near Victorville, Calif.

Jensen, Mrs. Jensen and Victor Keachie, pilot of the plane, who also died in the crash, were en route from Oakland, Calif., to Las Vegas, Nev., where Jensen was to address the American Mining Congress.

A graduate of the University of Minnesota, Jensen joined Hanna in Hibbing, Minn., in 1951 as an engineer and was transferred to the company's Cleveland headquarters in 1956.

Thomas Willard Parker, 90, former superintendent of mines in Butte, Montana, for the W. A. Clark interests, died in Butte, on Nov. 1.

A native of New York, he came to Wyoming with his parents when a child and to Butte in 1889. He retired from mining in 1929.

James A. Anderson, 68, mining engineer, died Oct. 22 in Butte. He had studied at the Colorado School of Mines and at Brigham Young University.

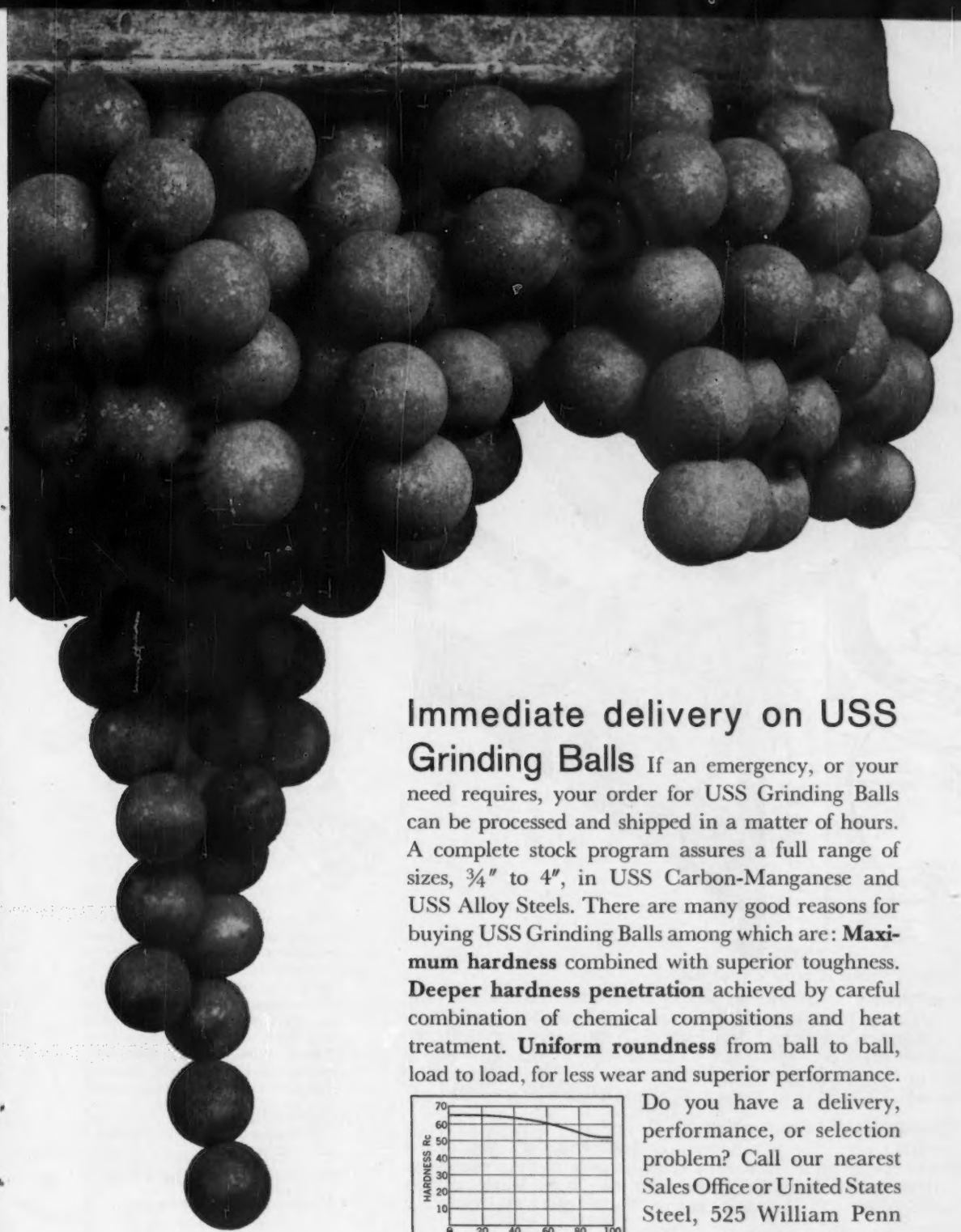
Mr. Anderson had been employed by various mining firms and had been self-employed prior to his retirement.

Charles A. Lemmon, 84, retired assistant general manager of Anaconda Reduction Works, died on Nov. 4 in Anaconda, Mont.

A graduate of Bucknell University in engineering, Lemmon joined Anaconda in 1905. By 1941 he was assistant general manager. He retired in Sept. 1956.

Lemmon was past president of the Montana Society of Engineers. He was a representative in the Montana Legislature for eight terms.

W. R. Easley, 53, vice president of Mohave Mining and Milling Co. and president of Mohave Engineering and Equipment Co. died recently in Wickenburg, Ariz.



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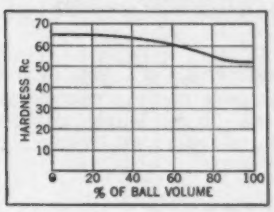

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USS

See the NEW McNally Pittsburg "SHORTY" Belt Conveyor

—that increases belt life, slashes maintenance cost!

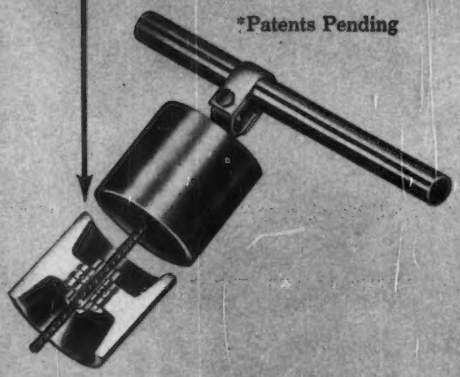
The "Shorty" unit is only 2 feet high!

The new "Shorty" underground conveyor featuring the new McNally Pittsburg Cradle Idler is ideally suited for use in limited working areas. Vertical supports are only 2 feet high. For extremely low clearance installations these conveyors can be made with 3" diameter rollers (instead of the standard 5"), and the average over-all height can be as little as 17" for a 36" belt, using a 30° deep trough idler construction.

For "Do-it-yourself" construction, the H-frames and stringers (which may be either wire rope or pipe stringers) are shipped disassembled and may be assembled in the field to fit any conveyor length necessary. It is only necessary to cut the stringers to the desired length, attach the Cradle Idlers and H-frames, and your conveyors are ready for operation.

Exclusive NEW Cradle Idler*

*Patents Pending



The secret of the dramatically improved performance and lower maintenance cost of this new heavy duty conveyor is the *true catenary suspension* of the Cradle Idlers. Since the rollers *rotate* on the steel rope, dangerous "loping and harmonics" cannot develop. The 5" rubber rollers, assembled on precision ground ball bearings, are prelubricated, lifetime sealed.

- Increased belt life—because full belt support is maintained under all conditions
- No creasing or cutting of belt
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McNally Pittsburg Mfg. Corp., Pittsburg, Kansas

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WHAT'S NEW IN PATENTS

OLIVER S. NORTH

U. S. PATENTS

Metal and Mineral Processing

Process for recovering tantalum values from ores, slags, concentrates, and like materials containing tantalum values. Ground ore is reacted with an acid or an alkali hydroxide or carbonate, and the reaction mass is leached with water and an acid other than hydrofluoric acid, and then leached with hydrofluoric acid to form fluocomplexes of tantalum and columbium. The fluocomplexes are contacted with a water-immiscible organic solvent, whereby the tantalum compounds go into the solvent phase and the columbium compounds into the aqueous phase. R. A. Foos, assigned to National Distillers & Chemical Corp. U.S. 2,950,-966.

To remove iron and other impurities from silica sand, river sand, or sand produced as a byproduct during beneficiation of phosphate rock, kaolin, feldspar, and the like, a slurry of the sand is mixed with hydrochloric acid and fluosilicic acid. After the impurities have been dissolved, the sand is recovered, washed, and dried. J. H. Gross, assigned to International Minerals & Chemical Corp. U.S. 2,952,516.

In a process for making non-magnetic iron oxide ores amenable to concentration by magnetic or flotation methods, the undeslimed ore is conditioned with any of certain chemical reducing agents, such as reducing sugars, metal salts of hydrophobic acids, etc. R. P. Cox, assigned to American Alcolac Corp. U.S. 2,952,532.

Design for a self-cleaning grate bar for ore-sintering-machine carriages or bands. One leg of the grate bar fork is made wedge-shaped, the wedge being directed toward the flange of the supporting beam W. Veith, assigned to Metallgesellschaft A.G. U.S. 2,949,289.

Roast-leach-precipitation method for the recovery of uranium, selenium and molybdenum values from high-lime ores thereof. Roasted ore is leached with sodium carbonate and hot carbon dioxide and oxygen gases. Uranium is precipitated as sodium metauranate from the first leach solution. Selenium and molybdenum are precipitated as sulphides from the second leach solution. The mixed sulphide precipitate is roasted to volatilize and separate the selenium. O. F. Marvin, assigned to A. E. Butterfield and A. K. Swann. U.S. 2,949,339.

To lessen the wear on iron-ore briquetting rolls and thus to lower replacement costs, the side walls of the cavities are formed of removable and replaceable hard metal inserts, fixed within slots in the roll body. E. H. Shipley, assigned to U.S. Steel Corp. U.S. 2,949,634.

Design for a device that will unload iron-ore balls or pellets from the side edge of a conveyor belt at an intended discharge point by tilting of the belt, without letting material drop off upstream or downstream of that point. G. H. Sundin, assigned to U.S. Steel Corp. U.S. 2,949,999.

In the recovery of sylvite from sylvinite ore, the final comminution is done with a dry impact crusher. Oversize is recycled to the crusher, and the through fraction is pulped in sylvite-halite brine, scrubbed, deslimed, and subjected to froth flotation. This process reduces the amount of flotation feed and improves the over-all recovery of potash. W. A. Smith and V. A. Zandon, assigned to American Metal Climax, Inc. U.S. 2,-950,007.

CANADIAN PATENTS

Metal and Mineral Processing

In the precipitation and recovery of tantalum and/or columbium compounds from ketonic solutions containing hydrochloric and hydrofluoric acids, potassium chloride, potassium bifluoride or other potassium salt is added to the solution. Double salts are precipitated in a finely crystalline and easily filterable form.

C. B. Brenthel, H. Rothmann and W. Keil, assigned to Gesellschaft fur Elektrometallurgie G.m.b.H. and Hermann C. Starck A.G. Aug. 9, 1960. Canadian 603,147.

Briquettes of iron-oxide ore or other metallic ore are made by mixing finely divided ore with marl or other clay-lime material, starch or a sulphate of magnesium or iron, and a hydroxide of potassium or sodium, and kneading and briquetting the mixture. The resulting briquettes have smooth surfaces, and the material does not smear the press. H. Dohmen, Aug. 16, 1960. Canadian 603,347.

A promoter or collector for use in the froth flotation of copper sulphide ores, particularly Chilean type ores, zinc sulphide ores, lead sulphide ores, and the like, consists of a mixture of optimum proportions of salts of dialkylmonothiophosphoric acid, dialkyl dithiophosphoric acid, and corresponding lower alkyl radicals in solution in cresylic acid. This reagent is lower in cost than most xanthates used in the flotation of ores of this type. R. B. Booth and J. K. Heeren, assigned to American Cyanamid Co. Aug. 23, 1960. Canadian 604,072.

In the recovery of uranium from ores such as Rand gold-ore concentrates containing uraninite, the material is mixed with lime and roasted, and the roasted mass is leached with a chlorinating agent to solubilize the gold and uranium values. The gold is precipitated by electrolysis, and the uranium is chemically precipitated L. Taverner and D. Millin. Aug. 2, 1960. Canadian 602,547.

A seal for the gas hood of an ore-sintering machine consists of an apron that extends down into pockets filled with a granular (e.g. sinter fines) or liquid sealing material, and protected from the effect of the heat of the charge on the grate. H. Rausch and K. Meyer, assigned to Metallgesellschaft A.G. July 26, 1960. Canadian 602,475.

BRITISH PATENTS

Metal and Mineral Processing

In an efficient method for reduction of finely divided iron-oxide ores, heat is supplied to a fluidized bed of ore by a hydrogen-enriched gas preheated to a temperature above that at which the ore particles agglomerate, in indirect heat-exchange relationship with the bed. When the temperature of the gas drops below the agglomerating temperature, it is brought into reaction contact with the bed. Agglomeration difficulties are minimized. Assigned to Hydrocarbon Research, Inc. June 22, 1960. British 838,067.

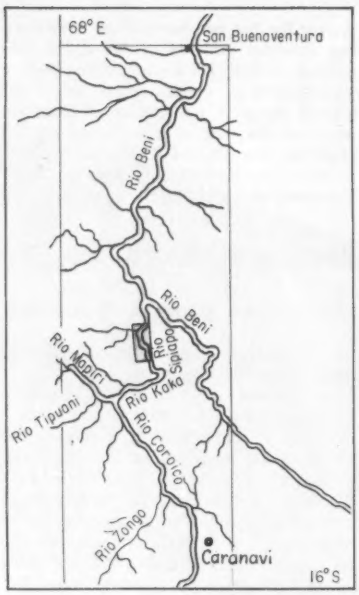
In a simple and economical process for producing pig iron, iron-oxide ore and slag-forming materials are delivered to a melt, which is maintained in a highly carburized state by continuously drawing portions of it into an evacuated vessel for carburization before return to the molten pool; thus the carbon consumed in the reduction of ore additions is effectively replaced. Assigned to Dortmund-Horder Huttenunion A.G. June 22, 1960. British 838,147.

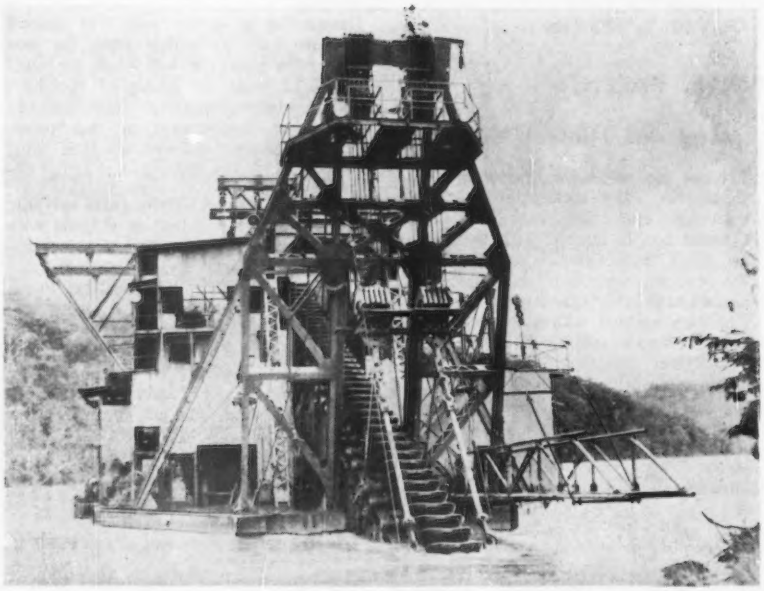
High-capacity, rotating multiple-cone apparatus for concentrating values from beach sands, alluvial gold-bearing materials, etc. The apparatus is readily portable, and does not require water for its operation. C. J. Garraty and R. Sampson. July 13, 1960. British 841,425.

In the recovery of the flotation reagent from the sylvite product obtained by froth flotation of sylvinite ore, the forth is treated with an aqueous alkaline solution to release the alkylamine reagent. Assigned to U.S. Borax & Chemical Corp. July 6, 1960. British 840,293.

In the production of lithium sulphate, petalite is calcined at 600-1250°C; the calcined material is decomposed with strong sulphuric acid at 150-400 deg. C.; and the reaction mixture is extracted with water. R. H. H. Morley. July 20, 1960. British 841,989.

Method for treating manganese garnet ore or other manganese silicate ore to convert the manganese to the easily recoverable pyrolusite form. Minus-30-mesh ore is roasted with sodium or potassium hydroxide, or sodium or potassium carbonate. In the roasted material the managanese will be found as manganese dioxide. G. P. MacKay and W. R. Trost. July 20, 1960. British 841,907.





CENTRAL BOLIVIA is the scene of South American Gold & Platinum Co.'s new operation. The site, on the Kaka River, is 30 miles from Caranavi, the terminus of a 200-mile highway which runs from La Paz. More than 5000 oz of gold per month are expected from the dredge. Opening of the placer deposit is the first major U.S. mining venture in Bolivia since 1952.

South American Gold & Platinum Starts Bolivian Operation

SOME 5000-plus oz of gold per month are now being produced from the first U.S.-Bolivian mining venture since 1952. South American Gold & Platinum Co., through its subsidiary, South American Placers, Inc. successfully transported a 2000-ton (displacement) dredge from New Guinea and began operation in late October on the Kaka River northeast of La Paz.

Lewis B. Harder, president of South American Gold & Platinum, characterized the operation as an important addition to his firm's gold production and a development which "significantly enhances the mineral production of Bolivia, which in turn participates through a sliding scale gross royalty."

The 2000-ton dredge, according to Patrick H. O'Neill, vice president of the parent firm, was dismantled in New Guinea, shipped by freighter to Arica, Chile, hauled by rail to La Paz, trucked to Caranavi and finally flown to the placer.

Some 1000 flights were required to move about 5000 tons of equipment. Fuel for power was sloated 40 miles downstream in 100-gal rubber tanks.

A complete living community was established at Teoponte for over 100 personnel connected with the project. Reconstruction, overhaul, and modernization of the dredge were completed late last year. A diesel electric plant supplying 700 kilowatts for the dredge and camp was installed. After several delays due to exceptionally heavy rainfall, floods, bedrock reefs and large boulders, the dredge was successfully moved 2½ miles upriver to its present location. The company anticipates that the dredge will operate in the general area approximately 15 years at a production rate of 5- to 6000 oz per month.

South American Placers' agreement with the Bolivian government was made in September 1956 and ratified by both houses of the Congress in December 1957. The contract provides that all equipment and supplies may be brought into the country duty-free, and that all gold bullion produced may be exported and sold in the free market. It also specifies that taxes cannot be raised or lowered during the length of the contract, which is for 20 years. The Bolivian government's concession to South American Placers covers an area of 37,050 acres.

Anaconda President Charles M. Brinckerhoff (l.) accepts a "Bronze Oscar" for the mining industry's best annual report from FINANCIAL WORLD publisher, Richard J. Anderson. Scene: 20th annual award banquet, N.Y. Statler-Hilton, Oct. 24.

". . .WE BELIEVE THE EIMCO 635 IS THE FINEST MUCKING MACHINE FOR THE PURPOSE ON THE MARKET TODAY," reports Shattuck Denn's Assistant Vice President, T.W.Newell

In a paper delivered to the Annual Meeting in New York of the American Institute of Mining and Metallurgical Engineers, Shattuck Denn Company reported in part as follows on the operation of their Bardon Uranium Mine near Moab, Utah:

"MINING A TABULAR ORE BODY LYING ON A 12 DEGREE DIP REQUIRES VERSATILE EQUIPMENT. MUCKING MACHINES AND HAULAGE UNITS THAT ARE CAPABLE OF NEGOTIATING 20% GRADES AND YET BE OPERATED EFFICIENTLY AND ECONOMICALLY HAD TO BE FOUND. A FIVE FOOT HEAD, AIR DRIVEN, TRACKLESS EIMCO MODEL 635 CONVEYOR LOADER UNIT MET THE MUCKING REQUIREMENTS. THIS RUGGED UNIT MUCKS BOTH UPHILL AND DOWNHILL ON THE DIPS ENCOUNTERED IN THE MINE AND CARRIES ABOUT TWO TONS IN ITS HOPPER AND CONVEYOR. THIS LATTER FEATURE IS ADVANTAGEOUS AS THE OPERATOR LOADS THE MACHINE WHILE THE HAULAGE UNIT DEPARTS TO THE SHAFT WITH A LOAD OF ORE AND THE SECOND UNIT POSITIONS ITSELF FOR A LOAD.

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BECAUSE OF THE PERFORMANCE, WE BELIEVE THE EIMCO 635 IS THE FINEST MUCKING MACHINE FOR THE PURPOSE ON THE MARKET TODAY."

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U.S. Uranium Miners Await AEC 1962-66 Rulings

THE NEXT 16 MONTHS will be crucial ones in the domestic uranium industry for those mines and mills which have as yet not been folded into the Atomic Energy Commission's purchase program ending Dec. 31, 1966.

Miners will be affected by AEC "recognition" of ore reserves in existence as of Nov. 24, 1958. AEC will not buy concentrates from reserves during period March 31, 1962 to Dec. 31, 1966, discovered after the Nov. 24, 1958 deadline.

For the future, the miners must look to a period without bonus payments for newly discovered ore reserves, as these payments ended this year; end of haulage allowances; possible new standards (including grade of ore) on amenability in shipping to mills, selected to participate in the 1962-1966 program.

About two-thirds of the existing mills and a substantial portion of all major uranium reserves already have been fitted into the program announced by AEC. The top limits of this program are budgetary in nature. There's some indication that AEC feels its initial budgets for domestic procurement will be exceeded, however.

Mills not yet signed to the 1962-1966 program include some whose tributary ore reserves are not expected to be of sufficient size to guarantee economic operations past current contracts.

Allan E. Jones, manager of the Grand Junction Operations Office of AEC, has indicated that some of these mills, for this reason, may not be operative in the new procurement period.

Significantly, it was disclosed in the industry that Kermac Nuclear Fuels, Oklahoma City, Okla., was discussing acquisition of Lakeview Mining Co. and subsidiary Gunnison Mining Co.

Principals, however, said that "nothing definitive" had been arrived at in these talks, but negotiations continue. Lakeview is controlled by the Murchison, Bass and Richardson interests of Dallas and Fort Worth, Tex.

Lakeview reportedly hasn't sufficient ore reserves tributary to 210-tpd mill at Lakeview, Ore., to carry it through present contracts ending on Nov. 30, 1963. Its mill has an original cost of $2.1-million.

Subsidiary Gunnison Mining Co., with a 200-tpd mill at Gunnison, Colo., built at original cost of $2,025,000, is somewhat better situated as to ore reserves. Its concentrates contract runs to Dec. 31, 1962.

The Thornburg interests of Colorado, incidentally, are no longer active in the management of these two companies.

Principals in Kermac and Lakeview did not disclose motivations in their discussions. However, it is a fact that many milling firms are actively investigating the existence of ore reserves not committed to mills.

Uranium Reduction Co., Moab, made a recent purchase of proved reserves in two claims in Utah's Big Indian district in this regard.

AEC says there's no bar to such purchasing and the buyer will be able to treat the ore in any mill of his choice, providing an existing contract isn't vitiated in the process.

Such deals are quite complicated, however, and require considerable analysis on part of both the buyer and seller.

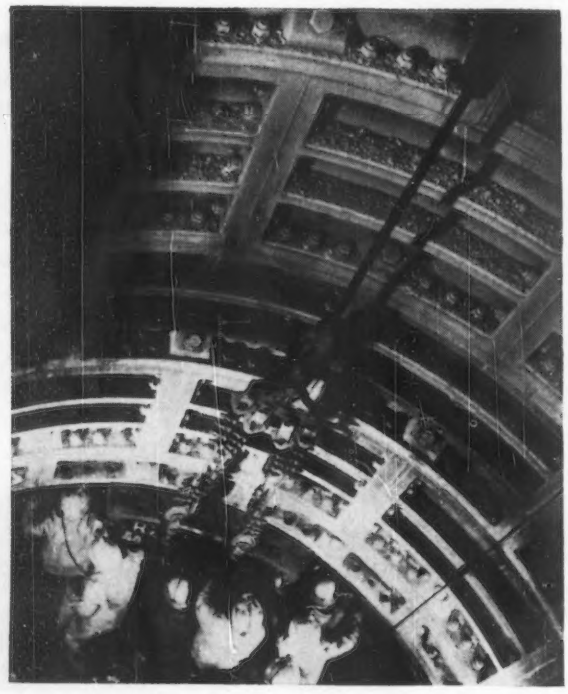
Meanwhile, AEC is moving toward releasing more information on milling contracts signed for the 1962-1966 period. The Commission hopes to be able to release a considerable amount of pertinent information in this regard in December.

The poundage figure alone will provide the industry with a better insight into the magnitude of AEC purchasing and will provide a guide to AEC policy in completing its contracting for the 1962-1966 program.

During the last two years the Commission has been: 1) fixing ore reserves in domestic mines, which reserves are "recognized" to have existed prior to Nov. 24, 1958; 2) signing mill contracts for deliveries of concentrates from date of the new contract through to Dec. 31, 1966; 3) completing a program having to do with a "limited expansion" of milling facilities in those mine areas where no mills existed for ores discovered prior to Nov. 24, 1958; 4) starting preparations for a small mine program based on a "historical classification" of those mines which would not have sufficient ore after the Nov. 24, 1958 to carry them into the 1962-1966 program.

To many in the domestic uranium industry, the actions of AEC at times have seemed contradictory and discriminatory. Why provide new mills in new mine

(*Continued on p 132*)



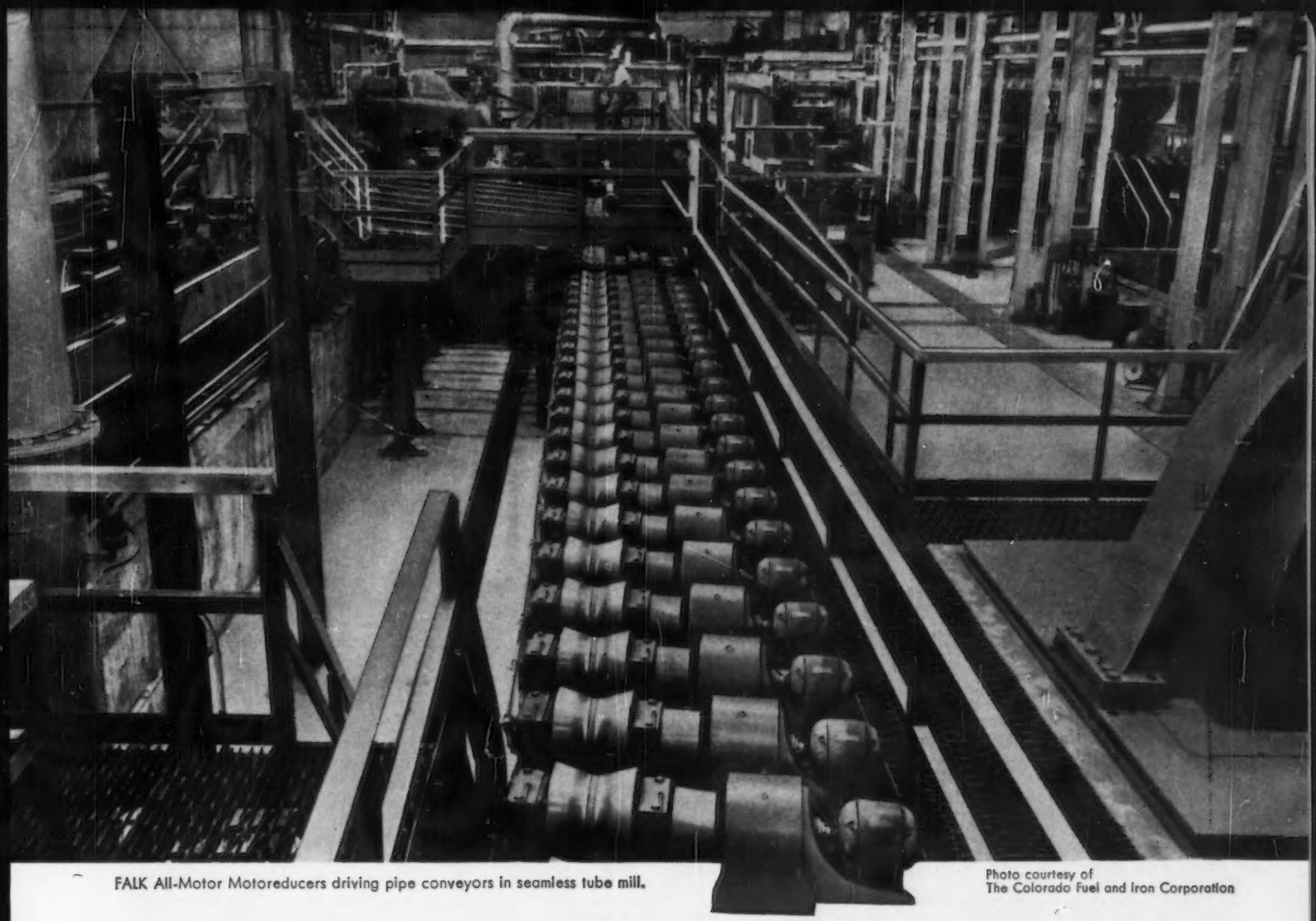
MINERS MUSCLE 4-ton segment of tubbing in place at 1300 ft level of shaft.

IM&CC Is Tubbing at Esterhazy

FOLLOWING A TWO-YEAR DELAY caused by flooding at the 1200-ft horizon, International Minerals & Chemicals Corporation of Canada's potash mine shaft at Esterhazy, Sask., is "proceeding satisfactorily," according to T. M. Ware, president. When water-bearing Blairmore sand was encountered in June 1958, various seepage remedies, including chemical grouting and reinforced concrete lining, were tried and abandoned. In May 1960, after extensive consultation with European mining engineers, IM&CC continued excavation, using a combination freezing and iron-lining process first developed by Germany's Associated Mining Construction, Ltd. The Blairmore has been frozen at minus 50° F by circulating refrigerant in the sand surrounding the shaft. Once frozen, the sand is excavated and a cast-iron lining, called "tubbing," is installed in five-foot increments, with 11 segments to each ring. When the shaft breaks through the Blairmore stratum at about 1450 ft, the tubbing "sleeve" will end and normal methods be resumed through the limestone strata to potash beds located at 3150 ft.

The tubbing is being installed by the German corporation, which is an amalgamation of four mining firms and which has sunk more than 700 shafts throughout the world, scores of them using the freezing-tubbing techniques now being employed at Esterhazy.

The mine is expected to go into production in fiscal 1961-62, opening up the world's largest high-grade deposit of potash. A surface refinery which will initially process 420,000 tons of potash a year is already completed.



FALK All-Motor Motoreducers driving pipe conveyors in seamless tube mill.

Photo courtesy of
The Colorado Fuel and Iron Corporation

You get these "extras" when you buy FALK *all-steel* Motoreducers

1. **Freedom from damaged housings.** The exclusive FALK *all-steel* construction gives full protection from cracked housings or torn-off feet...plus twice the ability of cast iron to maintain vital alignment.

2. **Inherently stronger gear teeth.** By AGMA standards, Falk extra-depth, high pressure angle helical gears are inherently stronger than ordinary helical teeth, thus assuring reliable operation and longer gear life.

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4. **Longer service life**...advanced FALK design makes it possible to machine both bores for each shaft assembly at one time, thus eliminating possible accumulation of tolerances that occurs when individually machined parts are assembled. The result—better alignment of revolving elements that permits units to transmit rated capacity longer.

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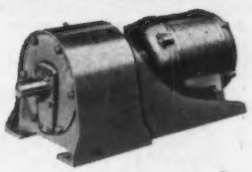

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(Shown) Horizontal concentric model. Also available in right angle and vertical types.

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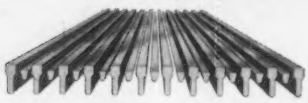


A new concept in guard bar design. T-shaped wire replaces typical "bar" to increase screening surface while keeping large unscreenable lumps of material above the tolerance governing lower screening surface.

"S" KLEENSLOT

For applications where screening out of flats or slivers is of prime consideration. Also furnished in a "C" bend. Recommended for applications requiring openings larger than 1 m.m.

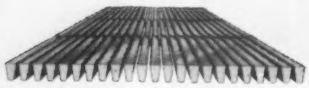
SCREEN GUARD

Vertical guard bars keep larger unscreenable materials above the actual screening surface. This increases screen life and promotes much greater efficiency in dewatering.

F217 and F250
KLEENSLOT

Large size wires maintain maximum efficiency over an extended period in abrasive applications.
Although large in wire size, this screen will maintain openings as close as 1 m.m.

MARCEL



This screen, while screening out "slivers," presents a flat surface for materials to wipe the opening clean Available with openings up to 1 m.m.—for larger opening see "S" screens.

G187 and GB187
MIGH-TEE KLEENSLOT

Special profile increases wearing surface. This is a heavy duty precision type screen that will easily maintain openings smaller than 1/8 m.m. and openings larger than ordinarily considered economical.

TAPER-SLOT

From loop to loop, the screen opening gradually increases. This design is to eliminate blinding when screening large amounts of near-opening size materials. For example: .016 opening tapered to .024—the combination of opening sizes would be the same between each loop throughout the entire screen.

Wedge-Wire Kleenslot Screens are custom manufactured to your application and are available in many sizes, metals and finishes. Our engineering staff will assist you capably and economically in determining the proper screen for highest production at lowest cost.

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SPACE FOR INDUSTRY

Uranium (*Continued*)

areas while arranging a stretch-out and a production limitation in existing mining districts?

The AEC takes the view that it must do this to be fair to all who held recognized ore reserves on the Nov. 24, 1958 date.

L. K. Olson, a member of the Commission, reported to the Las Vegas, Nev. meeting of American Mining Congress, that to date AEC has completed contracts into the 1966 period with about two-thirds of the domestic mills (involving 27 contracts).

It is still sifting through statements concerning ore reserves of operators as of Nov. 24, 1958. Some 2,650 properties involving thousands of mining claims are a part of this task. AEC technically has only until March 31, 1962 to complete this job.

However, in signing two recent contracts, it appeared to be providing for future shipments to mills from properties not yet segregated or which may land in the small mine category for which the special program will be initiated. So some reserve allocations could well be made after March 31, 1962.

These contracts involved Shiprock mill of Kerr McGee Oil Industries, Inc. and the Grand Junction, Colo., mill of Climax Uranium Corp. and provided a future 25% in pounds purchased on ores futurely available.

The heart of all future mining and milling rests with the amount of ore which AEC "recognizes" as existing and the commitment the Commission will issue in terms of purchase of "appropriate" quantities of concentrates from that ore reserve.

No uranium miner in the United States has any "inalienable" right to sell any pounds of U308, via the mill, to the AEC in the 1962-1966 program.

Despite some sharp criticism of the agency in connection with the signing of the big Petrotomics contract covering major production in Wyoming's Shirley Basin district, Allan E. Jones, manager of the Grand Junction Office of AEC, says this contract represented only "appropriate quantities" of purchasable pounds of U308.

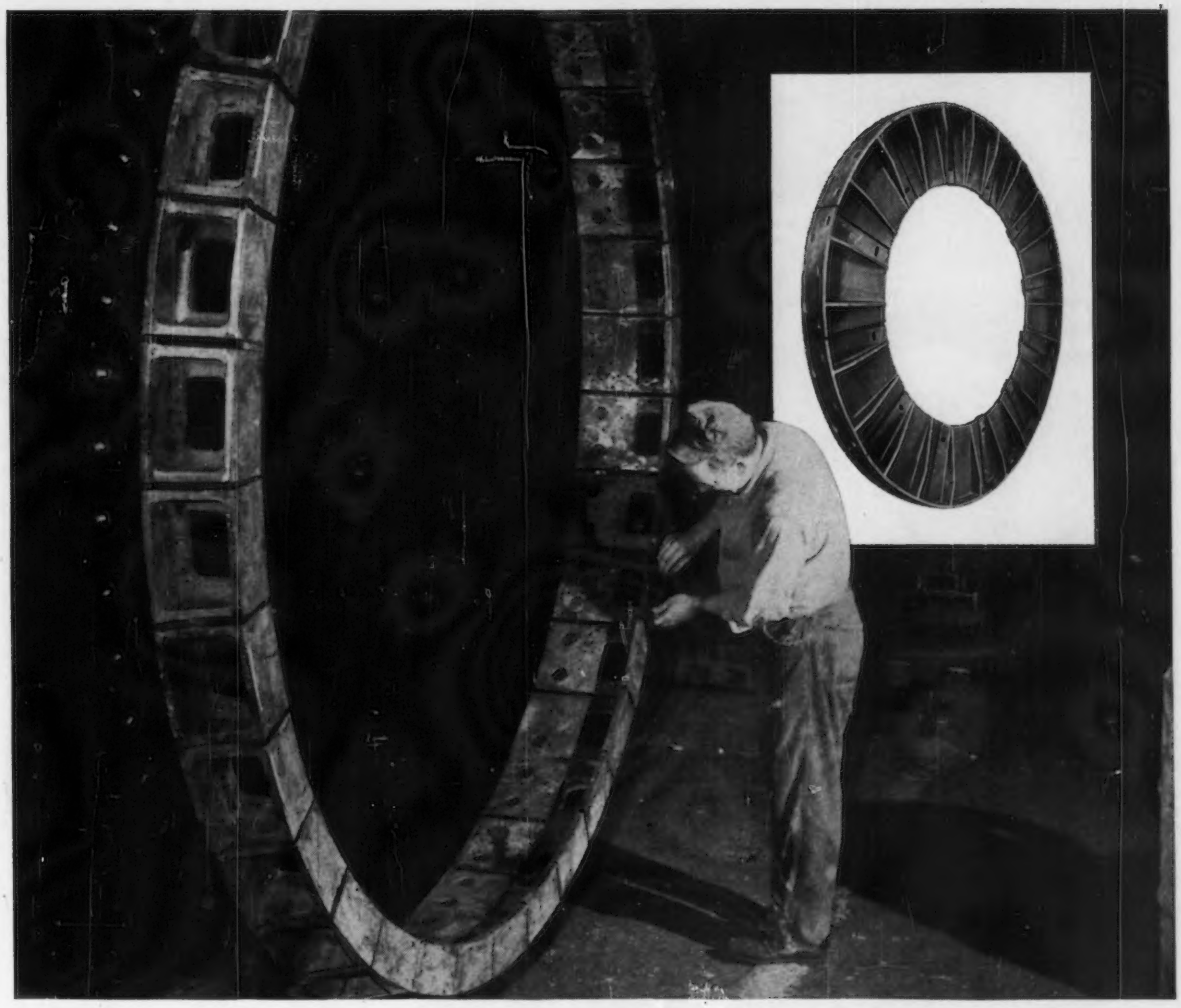
His inference is that Petrotomics Corp., representing a partnership of Kerr McGee and oil firms controlled by the J. Paul Getty interests, got far less pounds than in the recognized ore reserve.

In fact, AEC provides it will buy no more than 500 tons of U308 from any one property in any one year. And the Petrotomics contract is less than that 500 ton limit, Mr. Jones told E&MJ.

Only two firms to date have singly been granted the 500 ton maximum, Mr. Jones said. Both are in the Gas Hills district. A third 500 ton maximum went to several interests associated in a Grants, N.M. contract, he said.

The Petrotomics contract was also unusual from standpoint of its permitting Petrotomics to either build a mill (without special AEC amortization grants) or sell its uranium ore to some other mill.

E&MJ was assured by a spokesman for Tidewater Oil Co., which is operator



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Small size and light weight make B&W Castings easy and inexpensive to install. The protecting flange on the nose ring castings permits the use of low-alloy steel bolts for fastening.

Spare part inventory may be kept low because the same nose ring castings may be used on kilns varying up to 4 feet in diameter, depending upon size. Write for Bulletin S-17. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

S-467

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Uranium (*Continued*)

at the Shirley Basin unit, a mill will be built.

Mr. Jones feels that there probably won't be any other areas which could go ahead and build mills—as was the case of Petrotomics at Shirley Basin.

But AEC is not disposed to permit a mine near or tributary to an existing mill to erect a concentrator, and this provides problems for someone already in business. So Shirley Basin may be the last of the "big uranium deals."

AEC also recognizes that by being "liberal" with ore reserve interpretations, it would expand its commitments for concentrates purchasing.

By cracking down on the reserves "recognition," it could conceivably eliminate mills from the 1962-1966 program.

However, Mr. Jones stresses that the AEC has always dealt with the miner. The miller is a secondary link in the relationship. There is no obligation in the stretch-out period to provide new contracts just to keep mills going, he stresses.

He concedes there may be some mills which will not receive any contracts—or full contracts—through Dec. 31, 1966 because ore supplies tributary to these mills are running out.

Mr. Jones did not name these mills.

While AEC has some definite rules regarding what constitutes "recognized ore reserves" as of Nov. 24, 1958, it has not developed any yardstick as to its "appropriate quantities." The best guess is that AEC wouldn't want to fracture its budgetary commitments. So it will use a high degree of flexibility.

One standard in regard to purchasing pounds of U308 in the miners' ore reserve is not to render the property unminable from an economic standpoint.

For example, AEC may well buy all the recognized pounds in the reserve of Miner X and only a portion from Petrotomics—if by reducing through "appropriate quantities rule" the independent miners' reserve, it would make his properties uneconomic.

A factor in the new contracts is that the mill may elect to sell any uranium oxide it produces to commercial markets.

But if such sales were of a major nature, they would be subtracted from the 1962-1966 contracts. The Commission, of course, isn't buying any concentrates from ores found after the 1958 cut-off date.

Most of the major ore reserves in the U.S. have been committed to the 1962-1966 program. This is where the appropriate quantity rule has come into its largest play.

AEC is now processing the "intermediate" reserves and preparing ground for an announcement on its small mine program.

The so-called small mine program will largely affect the mines in the Uravan Mineral Belt. Mr. Jones has stated on several occasions, however, that other producers in other areas may be permitted to participate if they qualify.

AEC has given no indication as yet as to what properties will or will not qualify in this program.

But Mr. Jones has said it will be on a historical basis. Thus one could assume there will be some sort of a "participation date" regarding these mines. Such dates may go back so far as to exclude operators not located on the Uravan Mineral Belt.

The AEC is concerned with these small mines on grounds that none of the operators, because of the geologic nature of the deposition, know what their ore reserves are from month to month.

The forthcoming small mines program is certain to cause a good deal of controversy in some sections. However, there may be fewer mines affected than many in the industry realize. There are only some 400 or more properties shipping now in the domestic program. And with the end of haulage allowance, developmental bonuses and the like, contained in the expiring Circular Five Program, this number will be whittled even more.

AEC is limited in defense of some of its procedures by its own refusal to make public a number of contracts with private mills, and the terms therein.

But miners and millers alike should realize that in the new program the Commission has carefully reserved for itself the final say.

Some officials already indicated that contracting completed and ahead for the 1966 program may result in production of concentrates beyond the requirements of the agency for military purposes. But on the basis of contracting to

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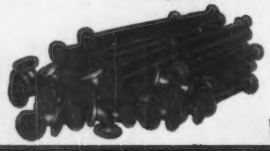

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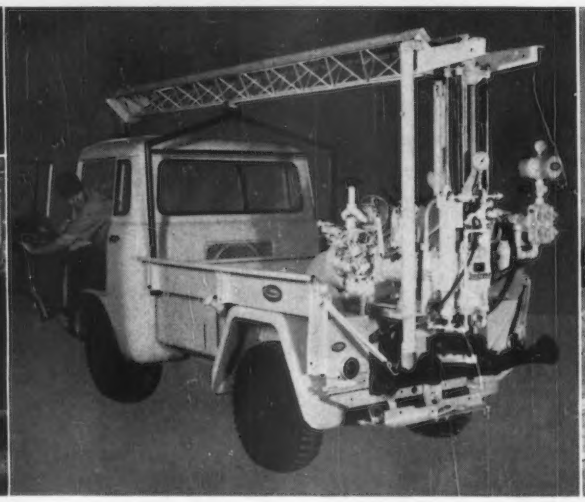

Adv. No. 152

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Uranium *(Continued)*

date, AEC may actually be buying less than anticipated.

And they believe it is entirely too soon to predict what sort of purchasing, if any, is ahead for the post-1966 period by AEC.

Most operators believe there will be some sort of a program. But the best guess is it will be even more stringent than the plan now being placed in operation.

AIME Agglomeration Symposium Scheduled

SEVERAL HUNDRED engineers, scientists, and industrialists from 26 countries have indicated they will attend AIME's International Symposium on Agglomeration, to be held at Philadelphia's Sheraton Hotel April 12-14, 1961. Papers written by specialists on all types of ferrous, nonferrous, metallic, and nonmetallic agglomeration processes will be distributed to the delegates in advance of the meeting to allow time to prepare written discussions. Preprints and abstracts will be available in English, French and German to all delegates, and included in the basic symposium cost of $25 to AIME members, and $27.50 to non-members.

Ronald McNaughton of Trail, British Columbia, president-elect of AIME, will give a welcoming address April 12, which will be followed by discussions of the predistributed papers. The symposium will follow directly upon the 44th Annual National Open-Hearth Steel Conference and the Blast-Furnace, Coke-Oven, and Raw Materials Conference, both to be held by the Metallurgical Society of AIME from April 10-12 at the same hotel.

South African Teamwork Perfects Shaft Sinking

SOUTH AFRICA'S record-cracking shaft sinkers are digging at speeds undreamt of a few months ago. They are already assuring the Union of South Africa and the world that the record of 1106 ft per month set in October 1960 at Hartebeestfontein mine in the Western Transvaal will not stand for long.

Hartebeestfontein and Zandpan mines' shaft supervisor, Martin Tucker, believes that "with a little luck and favorable rock conditions," a rate of from 1300 to 1500 ft per month is possible with present equipment and well-trained crews.

Shaft-sinking rates have doubled in the decade of the fifties (see p. 322 June '60 issue). Vaal Reefs mine in the Klerksdorp area broke the speed record twice at the end of 1959 with depths of between 900 and 1000 ft. Their mark was beaten very shortly afterwards by shaft-sinking teams at President Steyn in the Welkon area of the new Orange Free State goldfields, where the 1000 ft mark has twice been surpassed—a feat roughly comparable in mining circles to the achievement of the four minute mile. Even at that stage, the rate of 1100 ft per month seemed a distant target. But mining men in South Africa are

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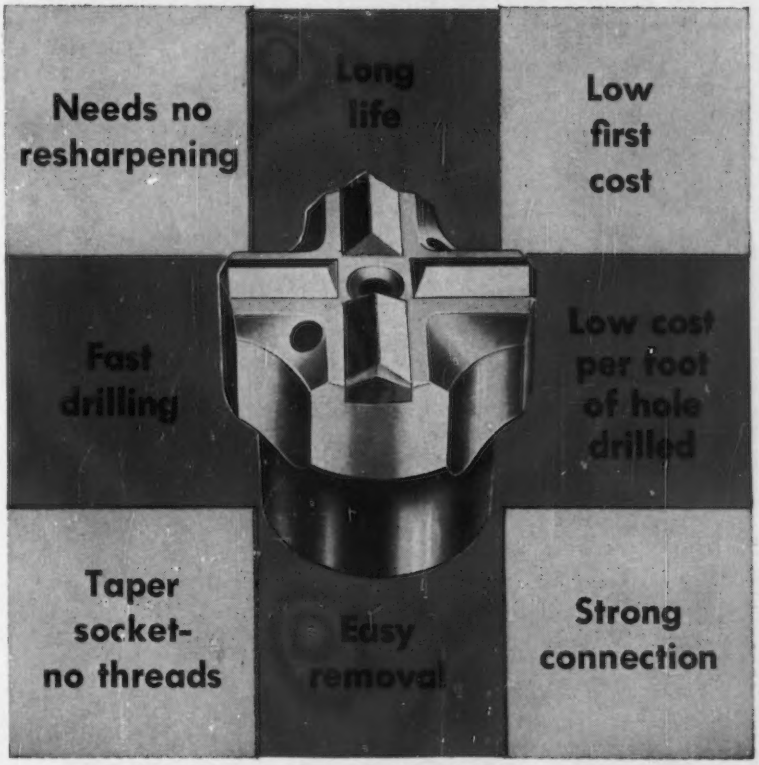

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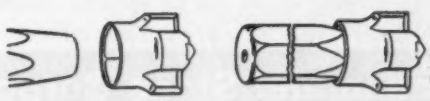

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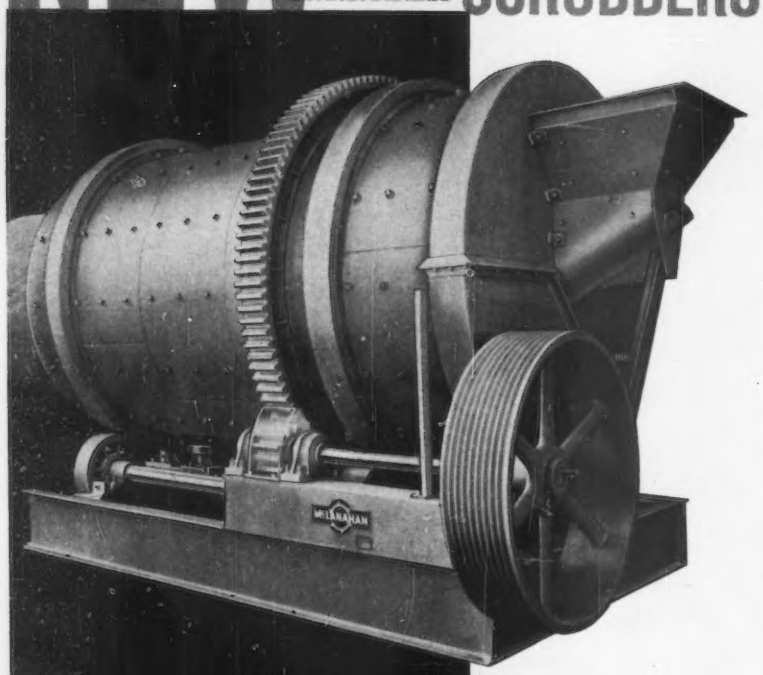

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Shafts (*Continued*)

now talking of shooting tor 3000 ft in three months. And so great are the strides that have been made in shaft-sinking techniques that a sustained 1000 ft per month could become a mining norm—in South Africa, at any rate.

In October 1960, Hartebeestfontein miners cleared 52,000 tons of rock in a confined shaft space of 26 ft, and simultaneously lined the shaft with concrete. For every foot advanced, 44 tons were excavated. The greatest amount lashed in an hour was 322 tons, although the monthly average was well under 300 tons. To ventilate the shaft, 58,000 tons of air were circulated; 721 ft of water-bearing dolomite formation was traversed; 50 tons of explosives were used.

There are two essential factors behind this type of record-breaking performance: teamwork and advance planning. In the South African mines, it seems that a third quantity has not been tabulated, but is abundantly present: enthusiasm. The decade of the sixties promises to provide some even more noteworthy statistics from that area.

Registration Climbs For Mine Research Panels

THE FORTHCOMING International Symposium on Mining Research promises to be one of the most complete and informative yet held. During the five-day session, Feb 21 to 25, some 46 papers will be delivered by authors from 11 countries.

The symposium will be held at the University of Missouri School of Mines and Metallurgy at Rolla and is sponsored by the institution and by the Bureau of Mines.

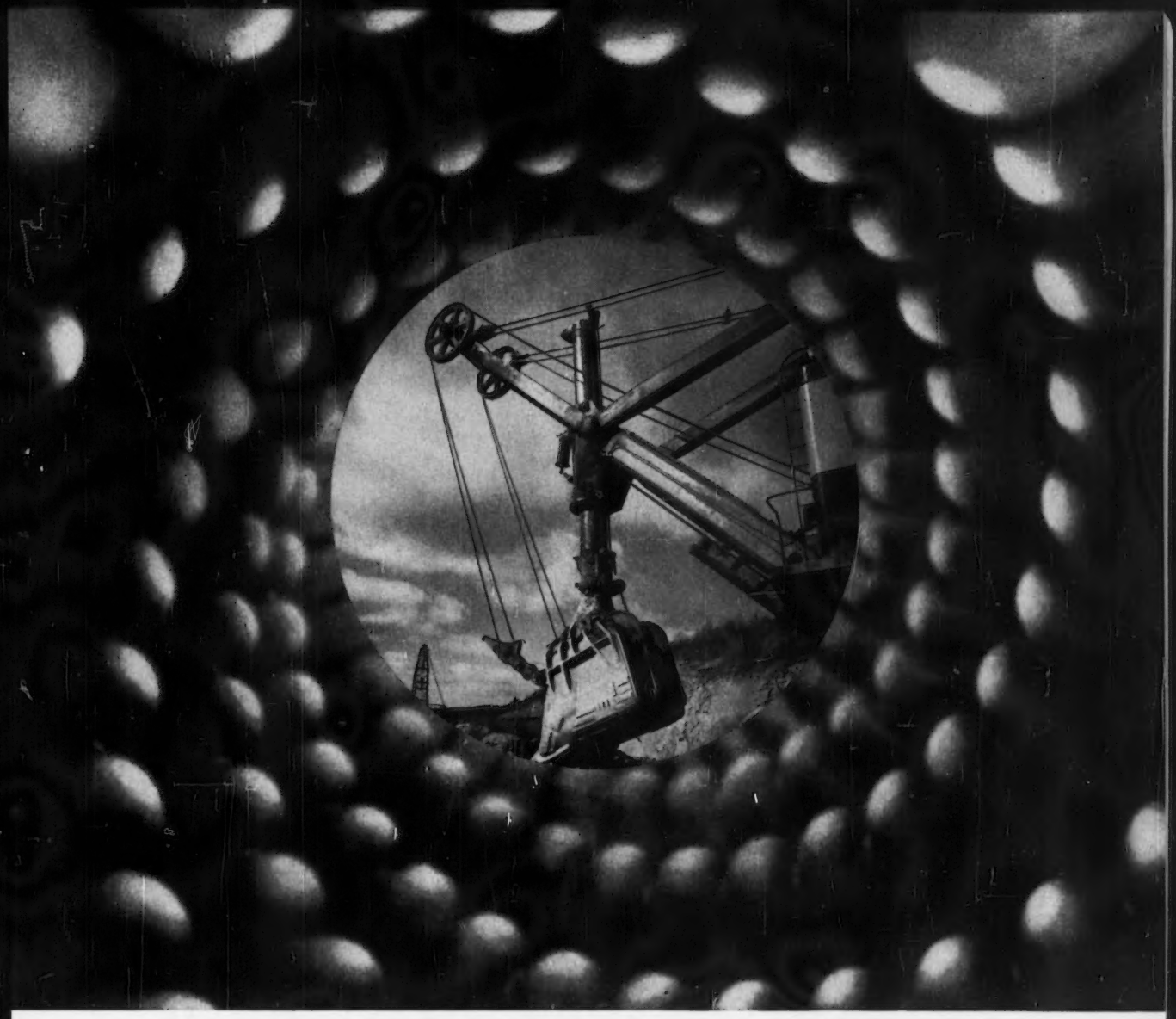
Topics for discussion will range from underground blasting with ammonium nitrate mixtures to the use of sonic techniques in exploring roof strata. Sandwiched between these is a host of papers on such pertinent topics as nuclear blasting, bench blasting, pneumatic loaders, stemming, fumes, blast pressure, explosive compositions and explosive evaluation.

Also included will be papers on rock mechanics and pressures, fluosolid ore pumping, ore analysis by X-ray and gamma ray spectroscopy and evaluations of drills and drilling methods. Numerous other papers complete the list.

All presentations will be given in three languages—English, French and German —by means of wireless translator equipment with individual earphones. Among the countries represented will be Australia, Austria, Canada, England, France, Germany, India, Japan, Sweden, the U.S. and the U.S.S.R.

Rhodesian Copper Miners Continue Expansion Plans

SOUTHERN RHODESIA'S Selection Trust copper miners are continuing to press plans for future development, in spite of presently cut-back operations due to a tapering off of Free-World copper consumption. As stated by Sir Ronald Prain, chairman of the group, "I have



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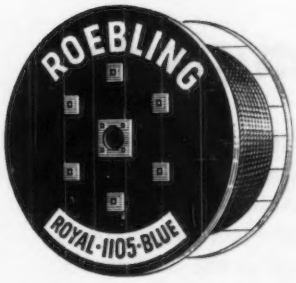

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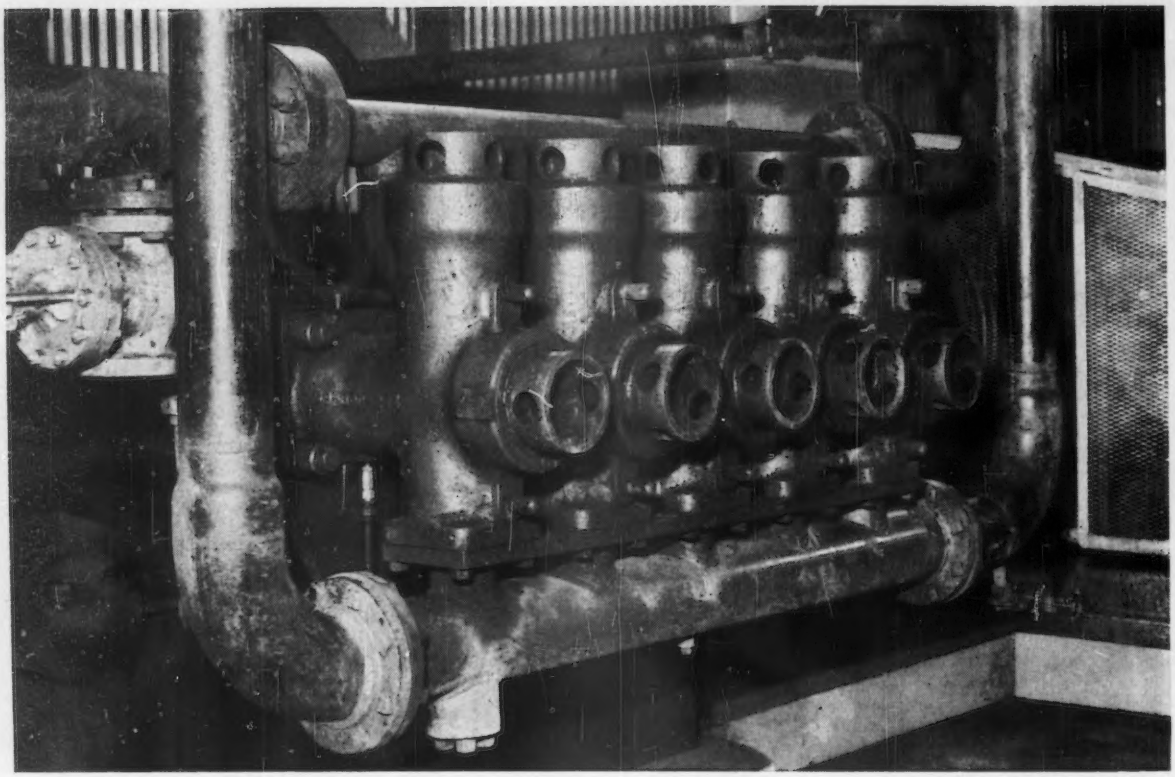

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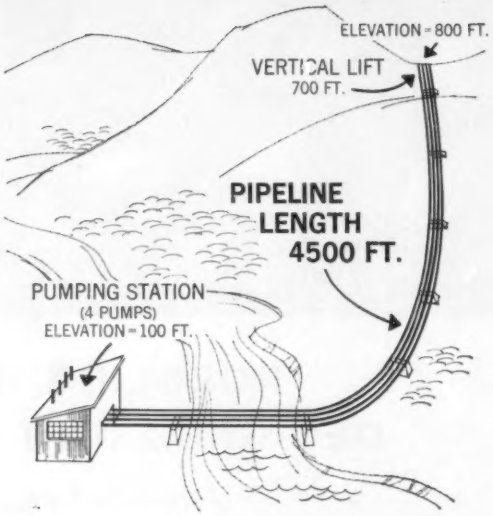
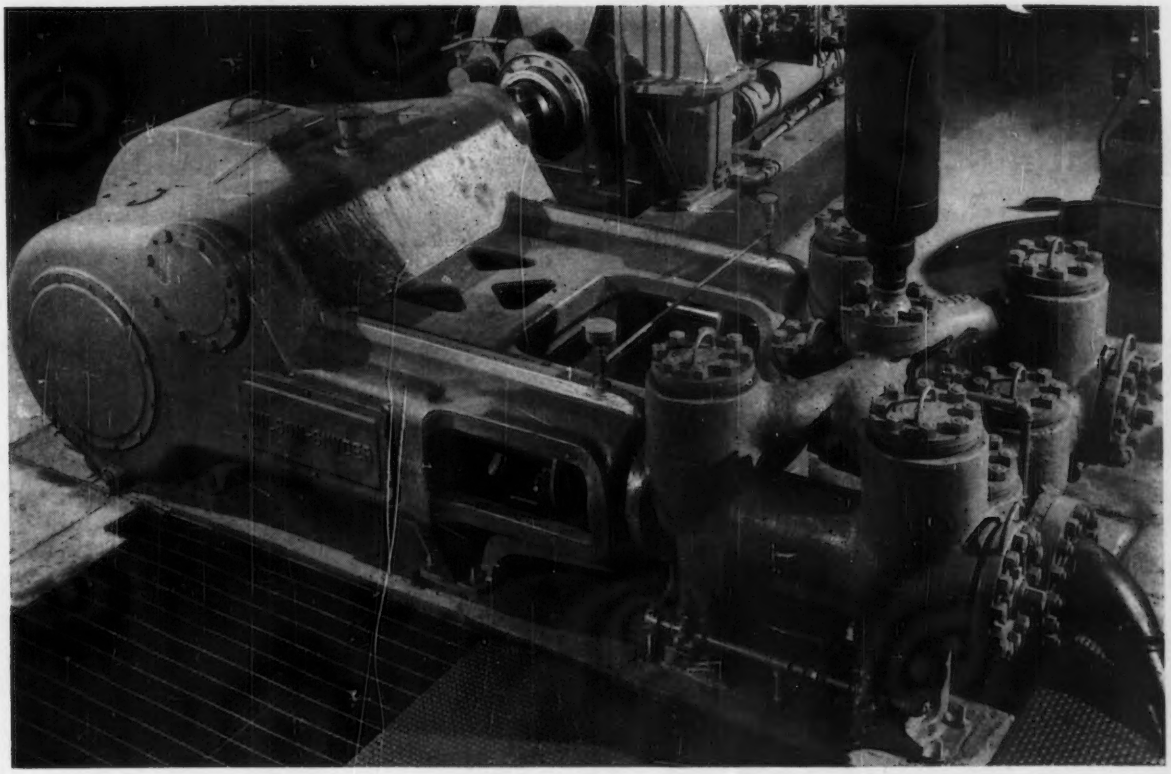


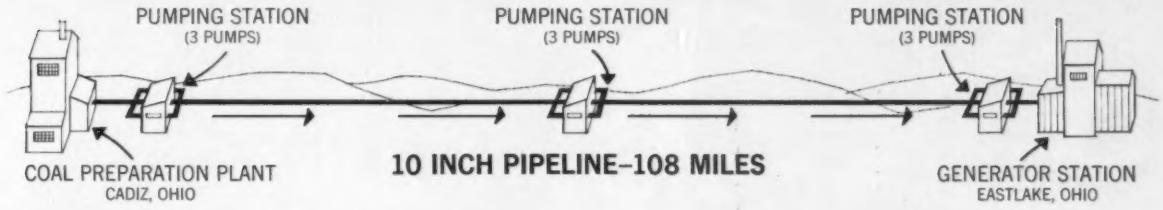
Short Haul . . . Use Wilson-Snyder Pumps for

The selection of the above installations emphasizes one important fact: Wilson-Snyder pumps are operating successfully and efficiently in both the long and short haul situations illustrated by these particular installations. It is important to know that Wilson-Snyder reciprocating-type pumps will perform successfully in applications involving the pumping of high pressure fluid-solids that cannot be handled by single-stage centrifugal pumps.

Wilson-Snyder pumps are available in a wide range of displacements, working pressures, and fluid-end designs and materials. Behind the successful performance of Wilson-Snyder pumps is the background and experience of Wilson-Snyder engineers, who are fully aware of the unique problems associated with each individual slurry pumping application. During



It's 108 miles between terminals on this line that carries coal in slurry form from Cadiz, Ohio to Eastlake, Ohio. Nine Wilson-Snyder Duplex Power Pumps do the moving. Line is operated by Hanna Coal Co. (Div. of Consolidation Coal Co.)



Long Haul . . .
high pressure slurry handling

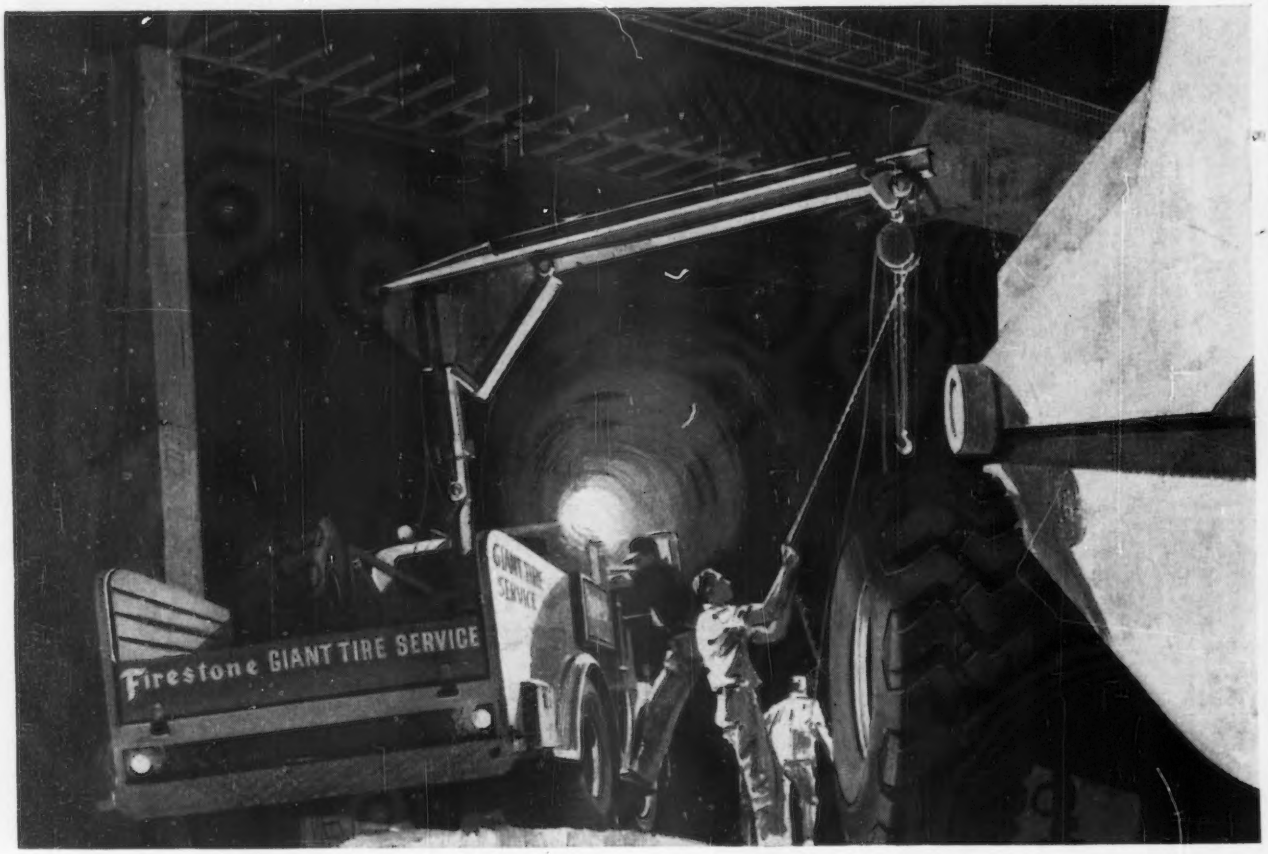
the early planning stages of your slurry pumping installation, let Wilson-Snyder lend their experience and background to your engineers to be sure of selecting the most suitable pumping equipment . . . this means Wilson-Snyder. *USS is a registered trademark*

Wilson-Snyder Works
Oil Well Supply
Division of
United States Steel

Braddock, Pennsylvania

This mark tells you a product is made of modern, dependable Steel

Firestone's Giant Tire Service keeps the wheels rolling..



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Connecticut, Hartford	BU 9-1551
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North Dakota, Fargo	AD 5-6448
Ohio, Akron	JE 5-4925
Cincinnati	PA 1-6816
Cleveland	BE 4-2012
Columbus	AM 7-6333
Oklahoma, Oklahoma City	JA 5-9461
Oregon, Portland	MO 5-8181
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Pittsburgh	MO 1-2100
Tennessee, Memphis	WH 8-4443
Nashville	CY 1-4122
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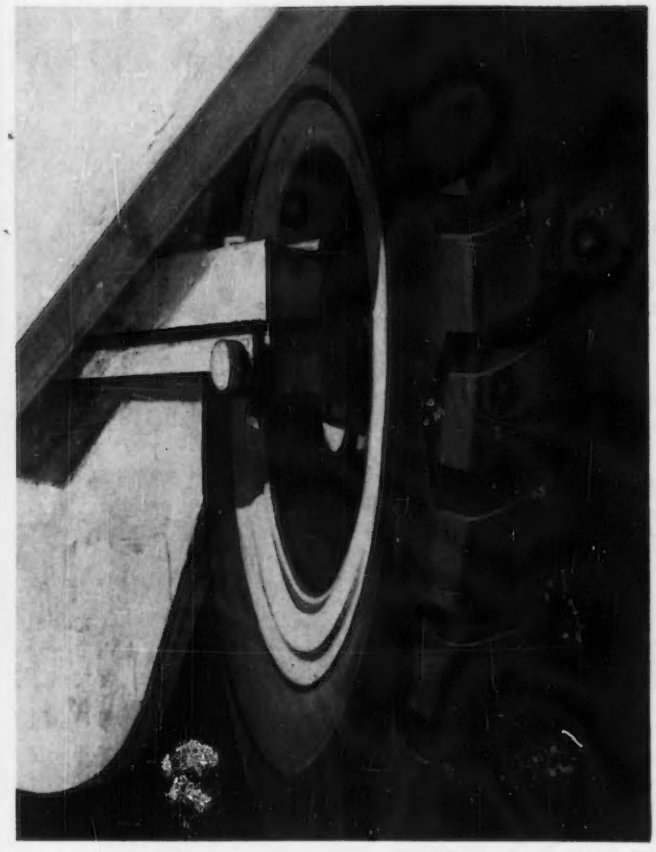
NIGHT & DAY

Super Rock Grip Wide Base* Super Rock Grip Deep Tread*

TUBELESS OR TUBED



You know how expensive tire downtime can be! The answer: keep it short. And with a Firestone Tire Expert on your project, it *will* be short. He'll do the worrying for you. He'll keep the correct pressure in the tires for every condition. Many times, he'll put the finger on trouble before it happens. But if trouble happens fast, he'll fix it fast. He can match new tires to any job, any rig—tires built with Firestone Rubber-X, the longest-lasting rubber ever used in Firestone tires plus the extra strength of Shock-Fortified nylon cord. So let Firestone take some of the risk out of those low bid jobs. Firestone Giant Tire Service is one of the best hedges against deadline pressure.

*Firestone T.M.

Firestone

BETTER RUBBER FROM START TO FINISH

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Tune in Eyewitness to History every Friday evening, CBS Television Network.

Rhodesia (*Continued*)

expressed my confidence in the copper market throughout many years, and nothing has occurred to alter my view in that respect." He added, however, that "future development and orderly growth of the industry depend upon maintenance not only of a correct price but a stable one. Production and marketing policies must be designed toward this sole end."

With regard to declining copper prices, Sir Ronald feels that careful policies of stock-retention and production-cutting would go far to introduce a greater degree of stability in the market. He feels that such regularly scheduled conferences as the International Wrought Non-Ferrous Metals Council greatly help producers and consumers to understand each other's problems.

Mexico's Bustamante Outlines Mine Laws

MINISTER EDUARDO BUSTAMANTE, head of Mexico's National Patrimony Ministry, gave some previews to E&MJ as to some of the clauses that would appear in the new mining law which was to be distributed this month. Here are some of the main items:

1) Limited time on concessions (now many concessions go until the ore has been exhausted).

2) No concessions without government's complete knowledge and approval of terms.

Your Postmaster SUGGESTS:

—Avoid The Avalanche Of Last Minute Holiday Mailings!—

To assure prompt delivery of all Christmas Parcels and Greeting Cards before the Holiday—

—MAIL EARLY!—

"For distant out-of-town points, mail by December 10, 1960."

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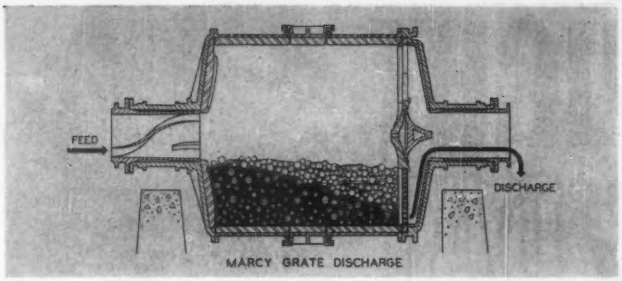
IDEAS AND EQUIPMENT FOR LOWER COST GRINDING

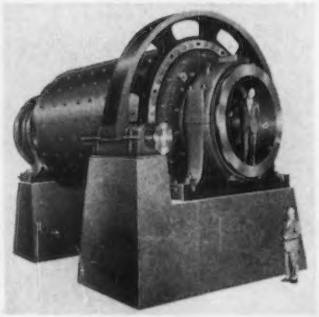
MARCY MILLS
are available in 29 different diameter sizes, from 12″ to 12′6″... all proven in the field... all built with mechanical specifications based on proven experience in the field.



MARCY GRATE DISCHARGE

Low Pulp Line

Mine and Smelter developed the principle of rapid change of mill content with a low pulp line obtained through use of grate discharge in Marcy ball mills and open end feature in Marcy rod mills. This Marcy principle increases tonnage up to 33%; decreases KWH per ton.

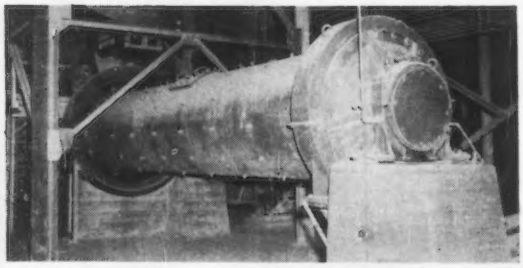


Large Diameter

Mine and Smelter pioneered the use of large diameter mills to meet the need of specific applications where large tonnage per mill reduced initial cost, provided more efficient grinding, and resulted in a lower overall net cost per ton.

2-Stage Grinding

Mine and Smelter's research and experience has resulted in many refinements in the grinding process, one of the most significant being 2-stage grinding... adding Marcy Open End Rod Mills between existing crushing and grinding stages, or replacing fine crushing. This has proven to increase capacity, produce a better ball mill feed, and reduce overall costs.



Engineering for Special Applications

Engineering grinding mills for specialized applications requires the kind of imagination and experience which Mine and Smelter has developed during the 45 years it has devoted to the art of grinding. Shown is a Marcy Grate Discharge Ball-tube mill, with peripheral discharge, designed for dry grinding high-temperature calcined gypsum from 100 mesh to as fine as 5000 Blaine. This mill provides flexibility in fineness of grind and accurate, convenient means of control.

The Company that cares enough to give you the best!

Manufacturing Division

MINE AND SMELTER SUPPLY CO.

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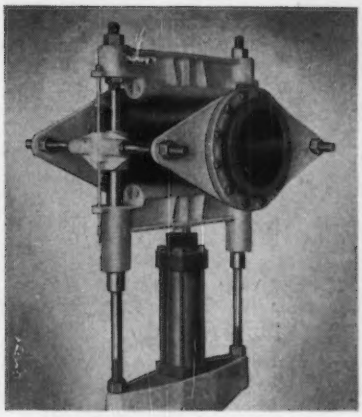

AUTOMATED
Hydral-60
PINCH VALVE SYSTEMS

Controlled circuitry for any operating requirements

- The Massco-Grigsby Hydral-60 System consists of one or more pinch valves with a single automatically operated hydraulic pump.
- Hydraulic pump may be operated by electric motor or by air from normal plant supply system.
- Valves may be the same or different size.
- Valves in the system may be operated simultaneously or independently.
- Control valve may be manual or solenoid.
- Valves may be coordinated and interlocked with other plant equipment to automatically control tank levels, rate of flow, etc.
- Valves are self-supporting and may be operated in any position from horizontal to vertical.
- Valves may be independently controlled for normal or rapid closure.
- Valves may be held fully open, fully closed, or at intermediate positions.
- Remote control to meet individual requirements.
- Controls may be included for automatic emergency operation.
- 3" to 14" I.D. sizes, with 50, 100, and 150 psi line pressure ratings.
- Temperatures to 200° F.

WRITE FOR NEW CATALOG NO. 609

Manufacturing Division

MINE AND SMELTER SUPPLY CO.

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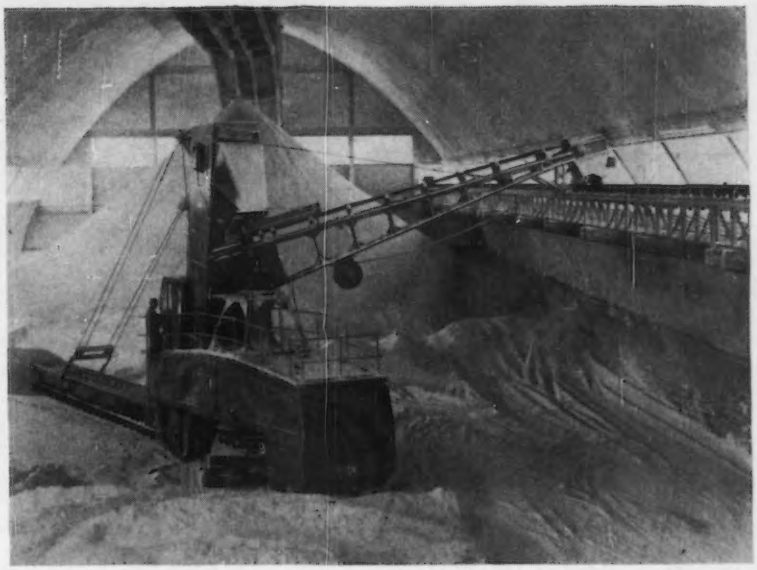

STORAGE at the new Montecatini plant is 20,000-ton capacity, with typical modern methods of materials handling. The plant will process 3,000 tpd of kyanite.

Montecatini Opens Kyanite Mine and Plant

MONTECATINI CO., Palermo, Sicily, has inaugurated what is described as Europe's most modern kyanite mine and fertilizer processing plant in the heart of Sicily. The new mine and plant incorporate automation facilities for nearly every phase of the operation.

Linked by 12 miles of cable cars which carry kyanite ore from the San Cataldo mine to the plant at Campofranco in the central part of Western Sicily, the new layout has a refining capacity of 200,000 tpy. Mine and plant will produce and process about 3,000 tons of kyanite daily.

Mining machines loosen the ore and shovel it to a conveyor belt which takes raw material to the "teleferique" for transport to Campofranco. At the cable car's terminal on the River Platani, an artificial lake has been constructed which holds 1-million cubic meters of water.

The kyanite deposit was discovered at 1,400 ft in 1953 after many years of prospecting and research. The deposit is estimated at 30-million tons. Company spokesmen say that the mine will be able to supply Italy's potassium needs in full and still allow 50% of its production to be exported. Previously, Italy had imported nearly $64-million worth of potassium products per year.

Bustamante *(Continued)*

3) No more "regalias" (royalties). Right now, the government is making a campaign against the royalty payments in mining, especially by the sulphur companies. The government claims that the sulphur companies, mostly Pan American Sulphur, have paid a total of $8.2-million dollars out in concession royalties over the last five years. Biggest royalty holders have been the Brady Brothers and two Mexicans, Manuel Urquidi and General Alfredo Breceda. Pan American Sulphur, the biggest royalty payer, has been given a time limit to "liquidate" its royalties.

ALLUVIAL DEPOSITS
Gold-Tin-Columbite-Ilmenite-Bauxite Rare Earths

Most accurately and economically tested for . . . with the

EMPIRE DRILL
NEW YORK ENGINEERING COMPANY

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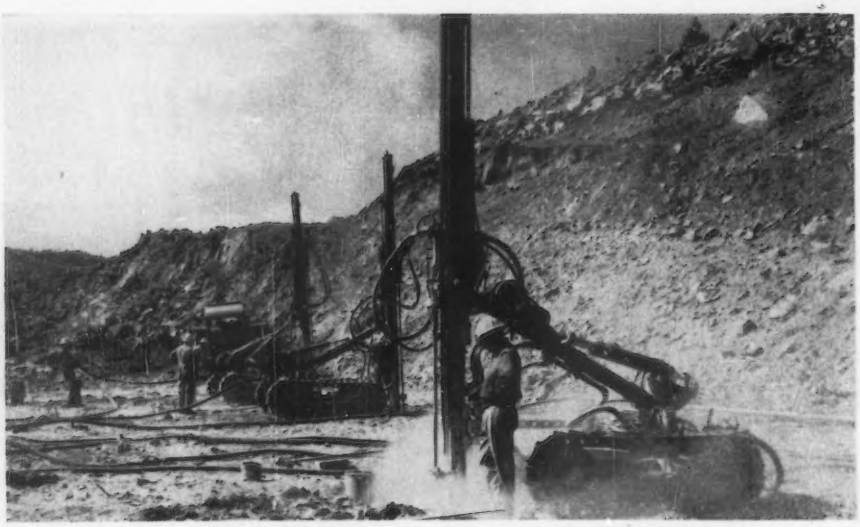


G-900 TRACDRILS with "Hydra-poise" knee-action have unmatched maneuverability and stability to sink blast holes in any formation. Independently operated, extra-long crawlers provide 1350 square inches of ground contact. Two sets of grouped controls — one at turret, the other at boom end — save time and steps for driller.

THIS BATTERY of CP-600 "Power Vane" Rotary Compressors feeds air to a group of G-900 Tracdrils. They supply the "Go-Power" for the toughest jobs with portability and "hands-off" operation.

G-900 TRACDRILS

PROVE THEIR POWER AND STAMINA IN THE TOUGHEST TERRAINS AND FORMATIONS . . . AND THEY CAN DELIVER MORE BLAST HOLES PER SHIFT FOR YOU!

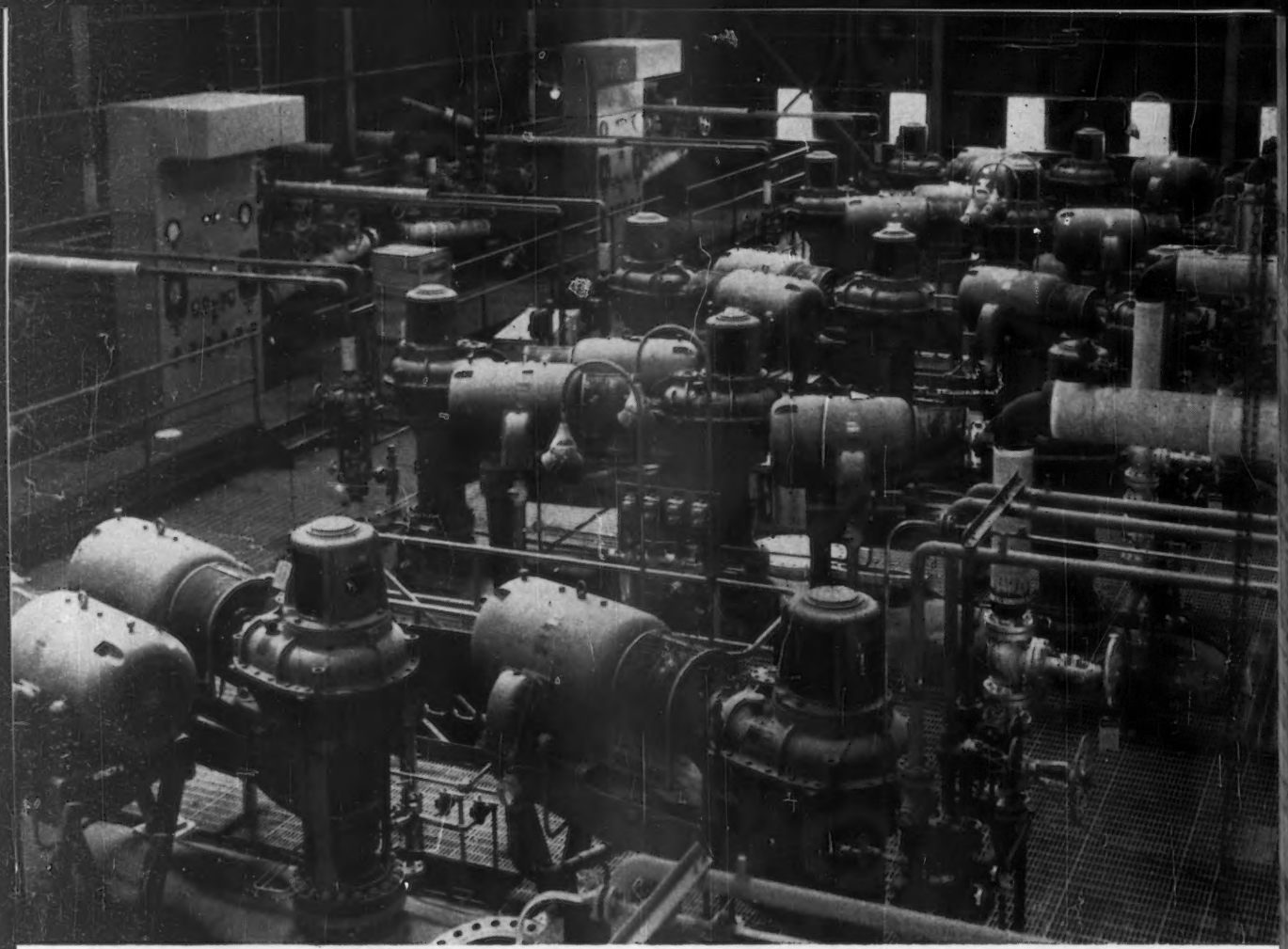
When you're stuck with treacherous footing and hard rock, you have a job for Chicago Pneumatic G-900 Tracdrils and "Power Vane" Rotaries.

Operators find the new G-900 a driller's drill. It's got everything a driller expects from a high production rig... plus some real exclusives, too! It can drill directly alongside tracks with 180° full swing. It handles horizontals 11 feet high at the face, or snake holes at ground level. And you can't beat the G-900 for safety. Release the throttle and heavy-duty brakes lock automatically . . . keep drill from shifting or creeping . . . hold hard on really bad ground.

If you back-up your G-900's with the rugged, always reliable CP-600 "Power Vane" Rotary Compressors that have the "Go-Power" to meet every air demand, you can lick the toughest formations you'll ever find. Write for Bulletin SP-3267 on the revolutionary G-900 Tracdril to: *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, New York.*

Chicago Pneumatic

TRACDRILS • AIR COMPRESSORS • PNEUMATIC TOOLS • AIR WRENCHES • REICHdrills



SETUP for a powerful lot of mixing

Beneath this forest of LIGHTNIN Mixers churns a small ocean of nickel being born.

You're seeing the country's first major refinery of the strategic metal—new 50-million-pound-a-year facility of Freeport Nickel Company in Louisiana. Mixing is a crucial step in the monster autoclaves that reduce nickel-sulphate solution to pure powdered nickel at high temperature and at pressure well over 600 psi.

As hydrogen hisses into the six autoclaves, 18 big dual-turbine impellers grip the heavy slurry and expose every ounce of it to the gas. As pure nickel forms, the mixers keep it suspended uniformly to seed the reaction. New charges of pregnant liquor flow in, and the densification process begins anew.

Each time a mixer starts, it may start with its lower impeller buried in settled nickel solids that throw a load of 300% of normal full torque upon the 125-hp mixer drive. A fluid coupling between motor and drive, and the distinctive hollow-quill design which is standard on Series E LIGHTNIN Mixers, insure that the shock never reaches the mixer drive gears.

Each mixer shaft enters the autoclave through a LIGHTNIN double mechanical seal that holds pressure leakage to zero. If it ever wears out, the seal can be replaced without dismantling the mixer, without removing it from the autoclave, and without disturbing gear alignment.

Engineers at Freeport Nickel *knew* what their mixing results would be long before they approved these mixers. MIXCO engineers lived with the project for months, checked power requirements by scientific methods, and demonstrated mixing results accurately in scale-model equipment.

If you'd like to take the guesswork and the risk out of fluid mixing on *your* next project, large or small, call in your LIGHTNIN Mixer representative. He's listed in Chemical Engineering Catalog and in the yellow pages of your phone directory. Or write us direct.

Lightnin® Mixers

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 234-n Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

Bustamante *(Continued)*

4) Concessions that are not worked within a given time will be turned back to the government.

5) "Incentives" will be given to foreign companies taking on Mexican capital, especially a majority (as in Peñoles case). Also, the mining companies will be given strong incentives if they put in beneficiating plants. Metals exporters will get better tax treatment if they put in metal-making plants. Pan American Sulphur said it had a plan ready to ship concentrated, molten sulphur to comply with this government wish.

Minister Bustamante said that in the case of sulphur, the government would now be able to control the industry more effectively because it had just completed a survey of its sulphur resources. He said Mexico had at least 60-million tons in reserves (proven) on the Isthmus (mostly at the Pan American dome). He added that at the rate of production and export, about 1.1-million tons yearly, Mexico could supply its own projected needs and its world markets for 50 years. Mexico also has around 50-million tons of sulphur in other reserves that would be harder to mine. Pemex, the government oil company, supplies the country's own needs with sulphur taken from sour gas.

Bustamante said that the price of Mexican sulphur has dropped from $30/-ton when Mexico entered world markets back in 1955 to $20/ton now. But the Mexican government and the Mexican sulphur producers (mostly, again, Pan-Am) have been pressuring the U.S. government to stabilize prices. Because of Mexico's vast reserves and economic dome at PanAm's site, Bustamante said "Mexican sulphur production has triumphed" in world markets.

Elsewhere in Mexican mining the new law which is to prohibit royalties on concessions was figured to disrupt payments to some 12,000 Mexicans in the north who have been receiving royalties for half a century or more.

New Dow Blasting Method Result of 8-year Project

DOW CHEMICAL CO. DEMONSTRATED a new combined explosive agent-blasting technique on the Mesabi Range in October 1960, but few details have yet been revealed to the press and mining public. The process, which utilizes a unique explosive, is called a "metallized system", and represents the fruition of more than eight years' research. The explosive is capable of being compounded at a mining site, presumably by local personnel.

In a bank face at the Mesabi test site, Dow specialists loaded and detonated four 10-in. holes with 1000 lb explosive each. The holes were spaced about 45 ft apart. The charge removed approximately 15,000 cu yd of hard, cherty taconite, which was well fragmented.

B. W. Romefelt, Dow's explosive field development manager, told observers that the company will supply advisory personnel to the mining industry from a

SIDE DUMPS for ROCK, EARTH, ORE

PAN ▸ TYPE truck bodies and trailers 14 to 45 TONS dumped by EASTON electric overhead hoist

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WRITE FOR CATALOG A

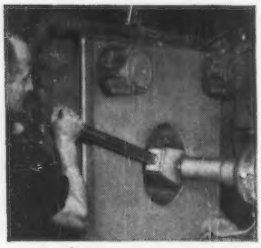
B-1084

EASTON®

the **SWENCH®**

LOOSENS TOUGH NUTS
THAT EVEN POWER
TOOLS CAN'T BUDGE

WHEEL LUGS on buses and trucks usually require the "beef" and skinned knuckles of two men to loosen. SWENCH does the job faster at less cost.



FROZEN HEX NUT on this molding machine caused 36 hours down time when removed by ordinary methods. Just 7 SWENCH impacts moved this tough baby.

RAILROAD HOPPER DOORS easily rust shut. Often it takes a 4-man crew a full day to loosen them. One man and a SWENCH does the job in just 7 or 8 impacts.

Discard that old-fashioned sledge. Put your torch away. Think before you buy another power wrench. Here's a *manual* wrench that delivers more effective torque than any other tool its size.

HOW?

Power wrenches deliver their torque as many tap-like blows. Ordinary hand wrenches apply a steady torque. Swench, on the other hand, builds up power in its super-strong spring for a mighty wallop, which is released as torsional impact every time the handle is advanced slightly more than 30 degrees. Swench multiplies torque applied to the handle more than 15 times.

Now one man can "Swench off"—in minutes—nuts that used to take a full crew a working day to burn or sledge off.

Swench is completely portable. No power connections needed. No auxiliary equipment to man and maintain. You save on man-hours. You save on maintenance. You save on initial cost. (Swench costs *much less* than a power impact wrench.)

You don't believe it? One demonstration will convince you. Line up your toughest job and give your Industrial Distributor a call. If Swench can't do it, no tool can.

Don't wrench it—SWENCH IT!

CURTISS WRIGHT

MARQUETTE DIVISION

1148 Galewood Drive, Cleveland 10, Ohio

Blasting *(Continued)*

newly-opened "explosives station" at Virginia, Minn. The station men will advise Mesabi range mines first, but will later be available to serve other mining areas in all phases of explosive engineering.

Soviets to Stress Synthetic Diamonds

SOVIET RUSSIA, despite having tremendous reserves of natural diamonds, is now placing great emphasis on manufacturing the synthetics.

During the six years since diamonds were found in Soviet Yakutia, the USSR government has spent vast sums to map out the fields and build power stations, roads, dressing plants and port installations. With what has already been done, plus development projects that are still on drawing boards, Yakutia should be able to keep supplying the country's priority needs.

Getting the diamonds from Yakutia, however, is not the easiest of operations. The Russians complain of long winters, permafrost, and lack of roads and other communications. They argue that synthetic diamond facilities could be built close to the labor supply, power sources, and eventual market outlet. Artificial diamond centers could be built at a much smaller cost and shorter time than needed for the development of new fields.

President A. N. Nesmeyanov of the USSR Academy of Sciences last July said that scientists had already synthesized ultra-hard crystals and that the forthcoming synthetic output could be the perfect addition to round out Russia's total diamond production.

Rio-Dow Ontario Thorium Installation to Be Built

CANADA's Rio Tinto Dow, Ltd., a producer of thorium compounds from domestic raw-materials, will build a new plant in the Elliot Lake area of Ontario. The new facilities, to cost about $400,000, will be completed by about March, 1961, at the Nordic plant of Rio Algom Mines.

The new installation will ensure continued production of thorium compounds with minimum interruption after Rio Algom has closed its Quirke Lake uranium mine and concentrator. The existing thorium plant at Quirke Lake will be placed on a standby basis.

IN THE U.S.

ALASKA

Kaiser Permanente Co. staked limestone deposits on Kings River last summer and plans to construct a $5-million cement manufacturing plant near Sutton. The plant will have an initial capacity of 500,000 barrels (2-million sacks) annually, and will calcine the limestone in a vertical kiln. Quality control will be marked by a high degree of automation.

Alaska *(Continued)*

Alaska Portland Cement, Ltd., a California corporation, has purchased claims encompassing limestone deposits in the Cantwell-Windy area, about 165 miles north of Anchorage. The claims were purchased from Alaska Limestone Corp. for an undisclosed sum and cover an area which had been previously investigated by the USGS and USBM. One deposit is estimated at greater than 200-million tons.

Nomura Mining Co., Ltd., Tokyo, is reported in negotiation with DeCoursey-Brewis, Ltd. for purchase of mercury and antimony soot from the Red Devil Mine and of a cinnabar prospect on DeCoursey Mountain, owned by DeCoursey-Brewis. Exploration and development of the DeCoursey Mountain property by the Japanese would begin next year if negotiations are consummated and approved by Nomura directors and the Japanese government. The Red Devil is the second largest mercury mine in the world with antimony soot as an important by-product. Nomura intends to do initial concentration at the mine.

CALIFORNIA

White Caps Gold Mining Co. has reported a "major find" of beryl-bearing ore on its Lone Pine property. Coring tests run to date indicate that extensive deposits of phenacite are present, together with lower-grade beryl crystal. Phenacite's presence has been confirmed by five tests, showing values of from 4.85 to 17.45%.

ARKANSAS

Reynolds Metals Co. announced in November that it tentatively plans to close most of its aluminum reduction plant at Arkadelphia in January, "unless the national business situation improves before the end of the year." Some 270 workers would be affected by a shutdown. A spokesman said the aluminum industry "is in a temporary position of oversupply," and that manufacturing costs at Arkadelphia are "higher than in other plants."

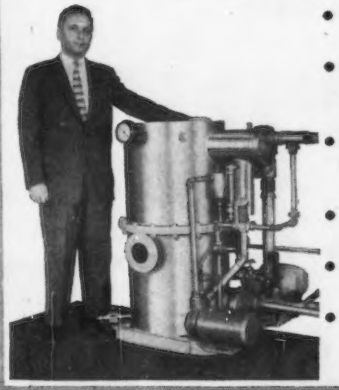
COLORADO

The U.S. Supreme Court refused (Oct. 17) to rule on the validity of a Colorado state tax imposed on La Salle Mining Co., producer of uranium, on U.S. lands.

Duke W. Dunbar, attorney general for Colorado, hailed the court's refusal as an important victory for the state and other states with similar mines-taxing laws.

La Salle Mining Co. had appealed to the U.S. Supreme Court, claiming that the tax is inimical "to the U.S. Constitution because it discriminates against the United States and those with whom it deals."

FRESH WATER
FUEL FREE
WHEREVER YOU HAVE A DIESEL
WITH THE NEW
AMF-MAXIM
AQUAVAP
HEAT RECOVERY EVAPORATOR



- A COMPLETE PACKAGED UNIT
- USES ENGINE JACKET WATER AS ITS HEAT SOURCE
- FRESH WATER FROM SALT OR BRACKISH WATER
- SIMPLE TO OPERATE
- INEXPENSIVE TO MAINTAIN
- LOW INITIAL COST

This new line of AMF-Maxim Heat Recovery Evaporators depend on engine jacket water, or any other hot water, as a heat source. Ranging in capacity from 150 GPD (which can be produced from a 30 HP engine) to 12,500 GPD, they are ideal for fresh water production wherever diesels are in use in locations that have some source of raw water, salt or brackish. Purity of water produced exceeds U.S. Dept. of Health requirements. Other AMF-Maxim Evaporators are available with capacities ranging up to more than 1,000,000 gallons per day.

For further information, write AMF-Maxim Evaporator Division at the address below.

LOW COST
FRESH WATER
for
REMOTE MINING OPERATIONS
CONSTRUCTION CAMPS
OIL DRILLING...

Sales and Engineering Representatives throughout the nation.

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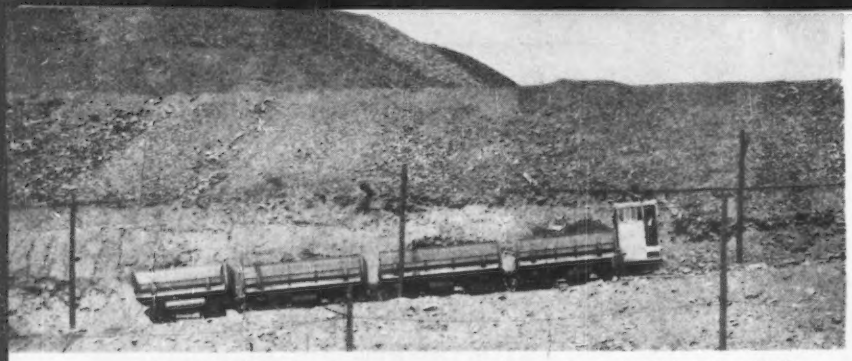
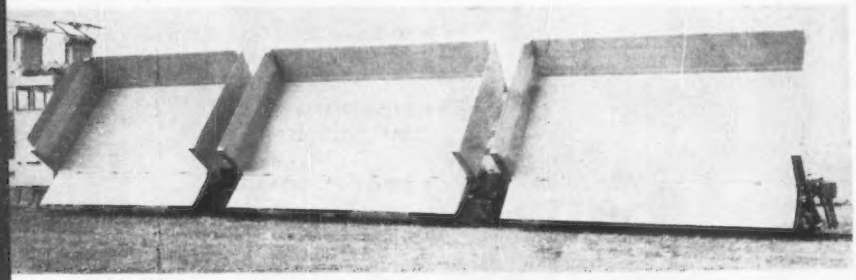


DIFFERENTIAL steep grade rail PACK TRAIN®

Up and down a 10% grade with DIFFERENTIAL ELECTRIC WHEELS for 13 years without an accident.

Uses trolley for fast climbing up 10% grade. Small auxiliary diesel-electric generator may be used for level track. With steel wheels on steel rails, tractive effort required is 5# per ton on level track, and 205# per ton up 10% grade.

Controlled speed with electric braking down 10% grade. Saves brake shoe and wheel wear. Capacities 1000 HP to 3000 HP.



PACK TRAIN uses rail all the way for lowest transportation cost. Dumps to either side all at once or one at a time.

250 HP DIFFERENTIAL two-way side dump WAGON TRAIN

A convenient way to unload. 45 ton highway train (15 tons in each wagon). 800 HP 90 ton off-highway train (30 tons in each wagon). Light weight trains haul heavy loads.

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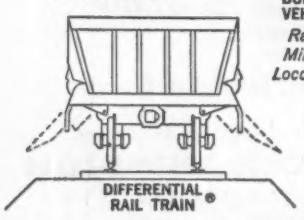
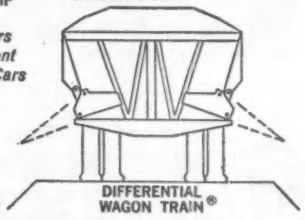


DIFFERENTIAL RAIL TRAIN ®

PATENTED



DIFFERENTIAL WAGON TRAIN ®

Rent Differential WAGON TRAINS from DIFCO, Findlay, Ohio

IDAHO

Coeur d'Alene Mines Corp., which owns extensive property in the Wallace-Kellogg area silver belt of Idaho, may resume work in their holdings, which have been idle for the past two years. There is reported to be a growing feeling among company officials that much of the below sea-level work recently done may have been too deep and that favorable St. Regis formations above should be explored.

Silver and lead recovered since February, 1960, in the Lucky Friday Silver-Lead Mines, Mullan, has averaged 98% of mill feed. A concentration in excess of 99% has been found on several days.

Iron ore mining started late in 1960 in two sections of the state. Near Gilmore, the Lyman Construction Co. of Salt Lake City, Utah, leased the old Bruce property where high grade magnetite had been known to exist. Near Mackay, the Nichols and Thompson Drilling Co., Boise, began drilling on the Ausich-Barton property.

Rare Metals Corporation of America, an affiliate of El Paso Natural Gas Co., is making a selection of operable thorium claims in the Lemhi Pass area of southeastern Idaho. A spokesman for Rare Metals said that the selection is being made out of 82 claims under option from Agency Creek Thorium and Rare Metals Corp., Salmon.

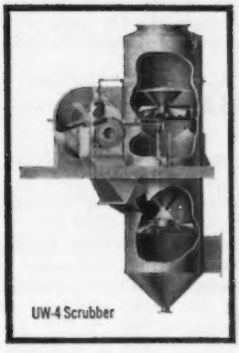
During most of 1960, RMCA has been assessing and evaluating the properties. It also has been conducting extensive research on possible uses of thorium as an alloy ingredient. Should RMCA mine the claims, the Agency Creek firm would share in 25% of net profits. The thorium properties are not being developed for nuclear applications.

Salmon River Scheelite Corp. has resumed production at its tungsten mine near Clayton. Output was resumed on what was termed a smaller scale after the property had been shut down for about a year due to low prices. Efforts will be made to find higher grade ore that can be mined more profitably.

KENTUCKY

A 10-year geological mapping project, financed by state and federal money, is underway. The state has been divided into 763 quadrangles for the project, and work on each quadrangle is expected to take an average of six months. Dr. Wallace W. Hagan, director of the Kentucky Geological Survey, said it will probably be 18 months before the first map is completed. The program is a joint project of USGS and the Kentucky Geological Survey at the University of Kentucky in Lexington. Kentucky's share of the cost over the 10 years is about $6-million. Dr. Hagan said that some of the existing geological maps of Kentucky counties date back to the 1800's and are highly inaccurate.

THE SWIRL, SWAT AND SCRUB METHOD OF CONTROLLING DUST



UW-4 Scrubber

There's an old song that goes something like this: "It Ain't What You Do; It's The Way That You Do It." This holds true for wet dust collection and one of the most effective ways of doing it is dynamically with a Ducon UW-4 Scrubber.

The centrifugal forces and water action inside this scrubber, combining with the unique and effective dynamic action of the high velocity fan in the second stage of operation, literally swirl, swat and scrub all the dust particles from the gas stream.

The UW-4 Scrubber is a most effective unit for separation of extremely fine dusts and abrasive materials and is ideally suited for heavy dust loads and high temperature applications.

Send for Bulletin 7460.

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CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

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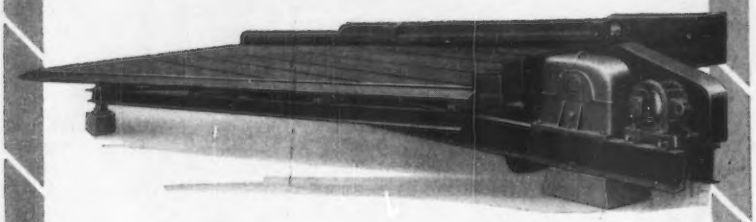
THE DUCON COMPANY, of CANADA, Ltd., 1121 Petrie St., BURLINGTON, ONTARIO, CANADA

Mineral Concentrates? Looking for Highest Grade



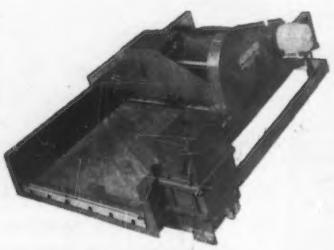
If you want the highest grade concentrates at the lowest possible cost, it will pay you to study the operation of the SuperDuty® DIAGONAL-DECK® table.

You can study it while it is in actual operation. Watch the finger-like riffles reach for the values and divert them to the discharge end where the bands of concentrate are so clearly defined that cutting is very simple.

With the utmost economy, you get high grade concentrates, exceptionally lean tailings and a reduced volume of middlings for recirculation. This is concentration at its efficient best. Send for Bulletin 118-C.

For Screening Economy

All New Model Leahy® screens utilize proven differential vibration that snaps oversize wedging particles loose 1600 times per minute. When dust is a problem, totally enclosed models are most effective. For damp screening, FlexElex® electric heating of the screen jacket insures full-time open mesh. For efficient wet screening CONCENCO® spray nozzle arrangements are your answer.



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MINNESOTA

Inland Steel Co., which had owned a 50% interest in the Pacific Isle Mining Co., is now sole owner. Pacific Isle will continue to operate iron ore mines on the Mesabi range. Pacific Isle has also sold its interest in the Coons-Pacific Co., which operates a commercial concentration plant near Eveleth, to the Pittsburgh Pacific Co. E. T. Binger, president of Pittsburgh Pacific, said the company's Cuyuna, Eveleth, and Mesabi range operations will not be affected by the transfer of control.

The Two Harbors iron ore harbor, now 26 ft deep, will be deepened to 28 ft in the inner portion, and 30 ft in the outer portion. The dredging will be done in 1961 at a cost of $162,000. When completed, it will permit loading of 25.5 ft-draft vessels. The channel deepening is to be part of the 27 ft Great Lakes Connecting channels project to accommodate deep-draft ore boats of the 700 ft class. Legislation is pending for an appropriation of $6,372,000 for deepening of the Duluth-Superior and the Ashland, Wis., harbors.

Erie Mining Co. cut production at its Hoyt Lakes taconite plant by about 14% in October 1960. The plant is now operating at a rate of 6.5-million tpy of pellets, instead of its normal 7.5-million tpy. None of Erie's 2,800 employees has been laid off, but work schedules have been reduced. Full production will resume when there is greater demand for ore.

Oliver Iron Mining Division mines have gone on a four-day week. There are also fewer winter stripping programs than usual. Cutbacks are attributed to reduced ore demand.

The M. A. Hanna Co. reports that essential parts for the $2-million semi-taconite pilot plant under construction at Cooley have arrived from Germany via the St. Lawrence Seaway. This equipment necessary in the conversion of non-magnetic hematite to synthetic-magnetic hematite, is not manufactured in the U.S. The Hanna Co.'s gas-burning kiln is 88 ft long, 8⅔ ft in diameter, and will have a 10 tph capacity. The pilot plant is scheduled to go onstream in late 1960.

MONTANA

The Montana Bureau of Mines and Geology reports that field studies have indicated the existence of a barite vein near Eureka.

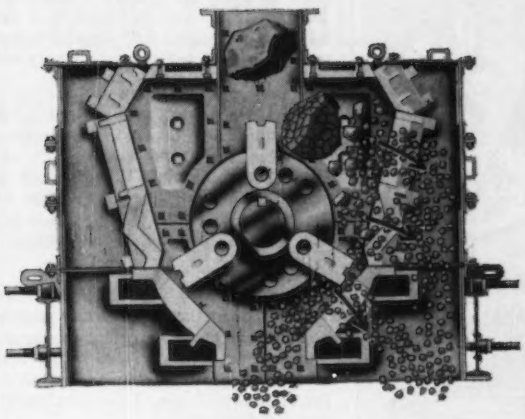
U. M. Sahinen, chief geologist for the bureau, said that the vein was found in the Tobacco River valley area of Lincoln County, about five miles southeast of Eureka.

The report said exposure of barite was made by a bulldozer cut 150x30 ft. The mineral zone was several feet wide and contained several bands of barite ranging from 5 to 16 in. wide.

Officials of Spokane National Mines, Inc.

Bulldog Reversible Impactor Hammermills

LARGER BREAKING CHAMBER RELIEVES CONGESTION



SIZED MATERIAL IS REMOVED THROUGH GRATES

Increases production as much as 50%

Grates on both sides of the breaking chamber let sized material through. The sized product is not dragged through the Impactor by the hammers . . . recirculating loads are reduced. This exclusive Bulldog Hammermill feature, plus larger breaking chamber, gives you greater production with less power . . . less hammer wear . . . lower reduction costs.

The fully adjustable center feed Bulldog also features push-button reversal. Provides a new set of hammer faces. Gives you the same quality product in either direction.

Size for size, the Bulldog Hammermill will produce more tons per horsepower with less maintenance cost than any Impactor on the market.

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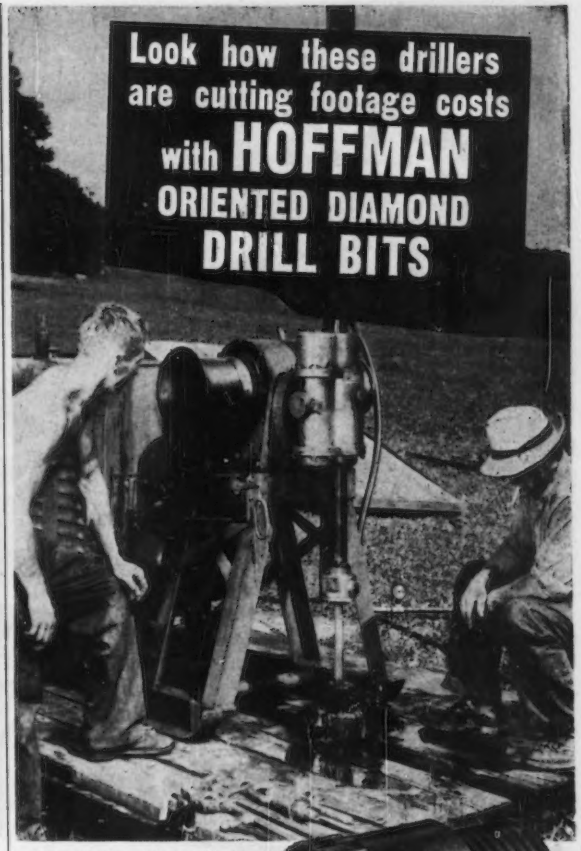

Photo courtesy Acker Drill Co.
Proving out deep coal veins.

other drillers are cutting costs too . . . with Hoffman Bits

Hoffman Bits are engineered to insure the greatest speed and efficiency for the specific formation being drilled. They not only cut faster with low power consumption . . . they permit more accurate job estimates from smooth, easy-to-recover cores.

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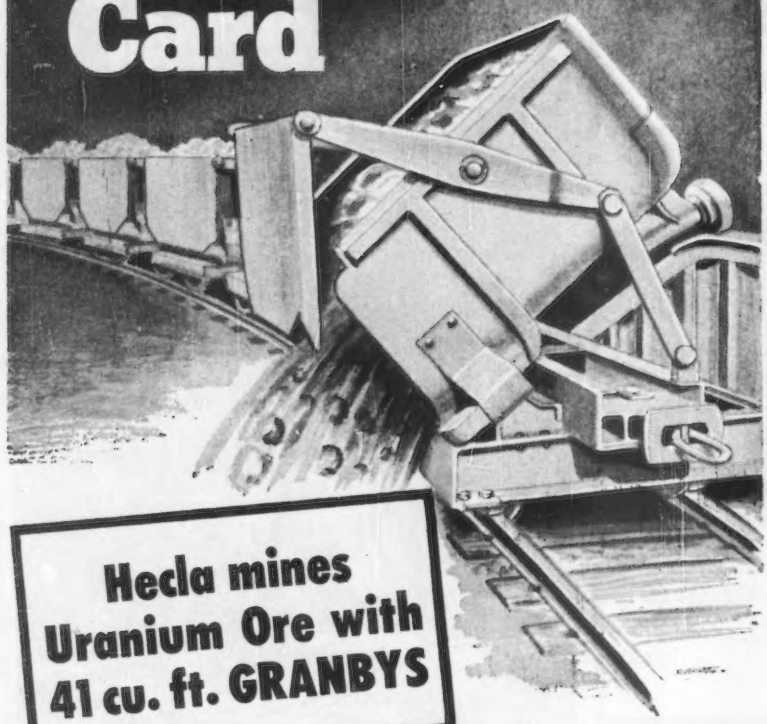
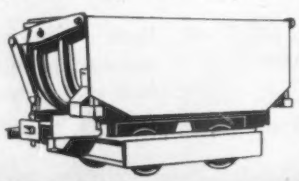


Hecla mines Uranium Ore with 41 cu. ft. GRANBYS

Hecla Mining Company opened their Radon property with 20 small Granby-type Card cars designed specifically for this underground service. Hecla is operating one of the deepest uranium mines in the U.S.A. with a well planned mine plant.

The underground haulage involves up to 300 tons per day of 0.7 percent U_3O_8 ore. Each Card Granby car has a capacity of 41 cu. ft. and is built on 24" gauge. When the Radon orebody is exhausted, the cars will still be able to "outlive" another Hecla mine of comparable size without major repair or replacement.

Such haulage efficiency and long life are yours whenever your choice is Card. Our engineers are at your service on any production haulage problem.



C.S. Card Iron Works Co.

2501 WEST 16TH AVE.
DENVER, COLORADO

Montana *(Continued)*

said five new silver veins have been discovered at the New Departure mine the company is operating at Bannack.

The veins range from 8 to 24 in. in width and were found under a 14-ft limestone capping. The new ore find may raise ore values at the property to 30 oz of silver per ton.

The firm recently completed a new road between the mine and the mill at Bannack. The mill is being run on a one-shift basis and capacity is expected to reach 150 tpd when new crushing equipment is installed.

Charles E. Taylor and Alfred I. Alf, Anaconda Co. chemists in the company's Columbia Falls and Great Falls operations, have received a patent for germanium recovery. The patent was filed for in November 1954. Alf already holds two patents covering the production of indium.

Senator Mike Mansfield has advised Montana newsmen that, should the proposed Bowman, N.D., AEC plant be opened, "most of the uranium from lignite would come from the Dakotas," and that a "small amount" would be purchased in eastern Montana.

Anaconda Co. reports that it does not consider expansion of its Berkeley Pit, Butte, to be economically feasible at present. Limitation of the pit to its present size will not conflict, the company says, with long-range plans for deep-vein mining operations in Butte, which are expected to bring about a 49% employment increase in a few years. Anaconda is also spending $100,000 to build a fence along the pit's perimeter, to deaden blasting and trucking noises for the benefit of nearby residents.

OME regional headquarters at Spokane has approved a $102,300 lead-zinc exploration project under a contract with Northern Mining and Milling Co., Inc., for drifting and crosscutting work at the Marietta mine in Broadwater County. The government will pay half the costs of the project, according to D. R. Mac Laren, acting field officer. It is one of the largest projects approved in the northwest in recent years.

Anaconda Co.'s multi-million dollar, deep-level mining development has entered another phase. The Kelley mine was closed for ore production from Nov. 24, Thanksgiving Day, through Sunday, Nov. 27, preparatory to shaft sinking operations.

Alterations will be made on the Kelley headframe, a preliminary job in connection with the shaft sinking project. The work will involve installation of a steel partition between the north and south compartments in the headframe.

Martin K. Hannafin, manager of mines, said the work originally had been planned to coincide with the installation of a new tipple at the Anaconda reduction works in Anaconda. However, the triple project work has been delayed, most recently by the wreck of a railroad car that was bringing a part from Texas.

TROUGHED BELT IDLER
Carrying type available with end rolls inclined at 20°, 35° and 45°.

TROUGHED BELT RUBBER CUSHION IDLER
Protects belt from damage by falling, heavy lumps at loading and transfer points.

8500 LINK-BELT idlers perform dependably

on world's longest permanent belt conveyor

Long-term dependability is built into the thousands of idlers in Ideal Cement Company's 5½-mile belt conveyor system. And the same is true of *every* idler Link-Belt turns out.

Rolls are accurately machined to assure concentricity. Frames are exceptionally sturdy with base, brackets and foot straps jig-welded to assure accurate roll alignment. Inverted-angle bases shed material . . . prevent build-up. These features plus effective seals, anti-friction bearings and ease of lubrication add up to dependability today . . . *and for many years to come!*

Link-Belt builds industry's most complete idler line . . . more than 759 types and sizes. Available with end rolls inclined at 20°, 35° and 45° for a broad range of belt widths. For full details, contact your nearest Link-Belt office or authorized stock-carrying distributor. Look under CONVEYORS in the yellow pages of your phone book. Or write for Book 2716.

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LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

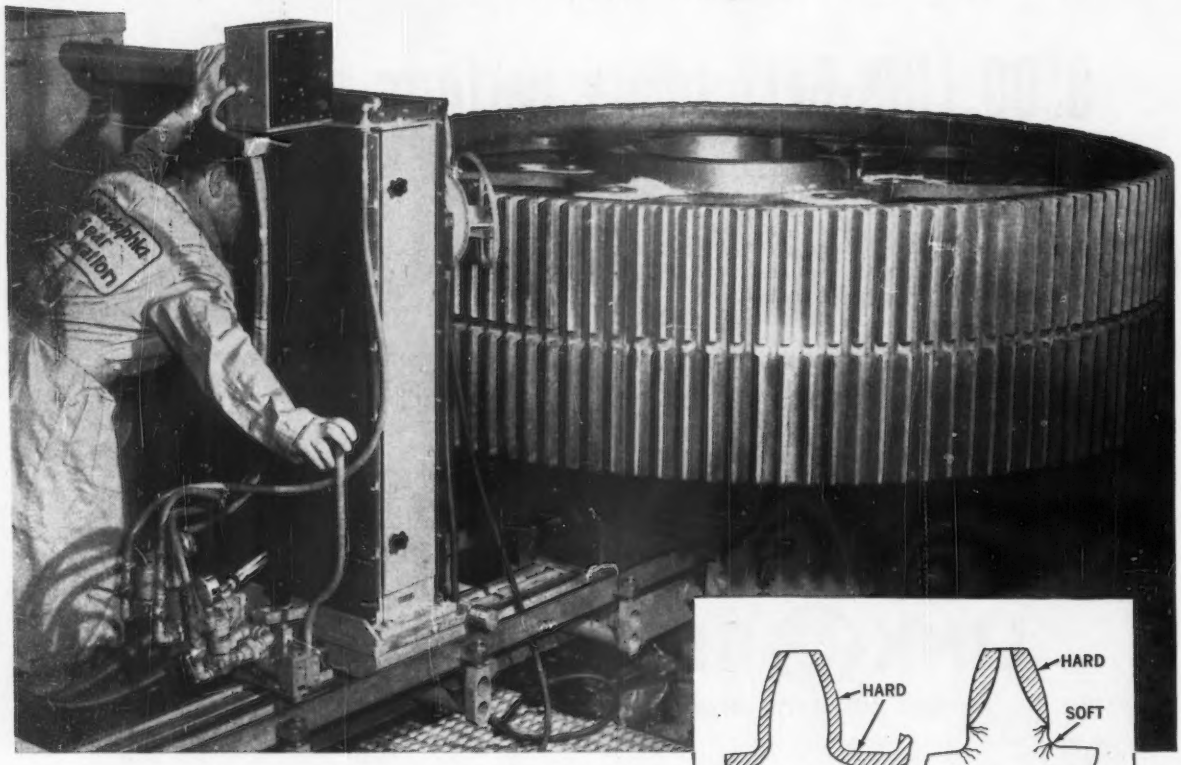
TROUGHED BELT-TRAINING IDLER
Automatically trains belt and protects belt edge from wear caused by misalignment.

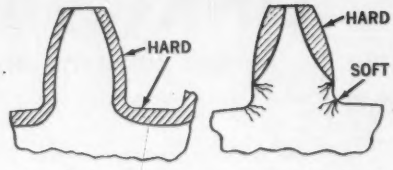
RETURN BELT IDLER
Supports empty belt on its return run.

RUBBER TREAD RETURN BELT IDLER
Extends belt life by reducing tendency of wet or sticky materials to cling to belt.

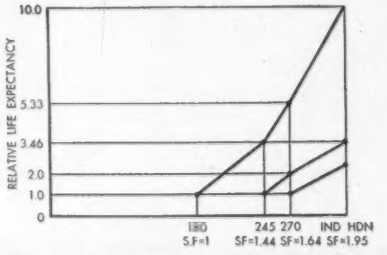
BIGGEST HAUL YET IN RAW MATERIALS. Ideal's new 3-million-barrel plant at Ada, Oklahoma, receives 1000 tph of limestone and shale via world's longest permanent belt conveyor system. The quarry is at Lawrence, Okla., 5½ miles away. 15,408

New Philadelphia induction hardening increases life of large gear drives . . .





New Philadelphia full contour induction hardening (left) provides a continuous hardened area from one tooth flank around the root and up the other flank without interruption. There are no points of stress. Typical heat treated gear (right) shows inadequate hardening of root of tooth, a point of major stress.



This chart shows the relationship between load and gear life. Note that the improved service factor of a gear set may be used to substantially increase gear life, rather than to increase the load.

HERE'S WHY: Full tooth contour induction hardening of large gears provides a uniformly hardened surface from one tooth flank around the root and up the other flank without interruption. Eliminates points of thermal stress concentration. And there is no distortion, a problem of heat treated gearing that requires subsequent grinding.

This new, advanced Philadelphia method permits radical reduction in sizing and/or increased load carrying capacities. And it can easily harden even the largest spur, helical and herringbone gearing up to 180 inches in diameter, 20 inches in face, and 3/4DP.

Learn more about this new method for increasing the service life of your gear drives. Write for your copy of Bulletin 100.

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King of Prussia (Suburban Philadelphia), Pennsylvania

Montana (*Continued*)

The Kelley headframe partition will separate the two north and two south compartments so that one side can be used for production and the other for shaft sinking. A temporary bin will be installed to handle waste from the sinking operations. Before the sinking starts early next year, 279 ft previously excavated in the No. 1 shaft will be concreted. The shaft then will be deepened and concreted another 1715 ft below the Steward 3000-ft level.

The development program calls for the Kelley to become the central hoisting shaft for ore mined on deep levels of the Mountain Con, Steward, Leonard and, at a later time, the Belmont mines. Large haulways will be established from the Kelley to the Mountain Con and Steward in the 4400-ft level and to the Leonard on the 3900-ft level.

Work under way on the multi-million dollar project has included that at the Tuolumne pumping shaft on the east side of Butte Hill and in the Steward Mine where an engine room was set up on the 3900-ft level.

MICHIGAN

The new plant of the Alnore Mineral Co. will be in operation soon at Erie. The plant, which will offer a custom grinding service, is equipped to reduce ore of average 6 in. lump size down to various sizes ranging from 20 mesh to sub-sieve particle size. Extremely fine particle products will be reduced in a ceramic-lined Majac mill operating with superheated compressed air.

NEVADA

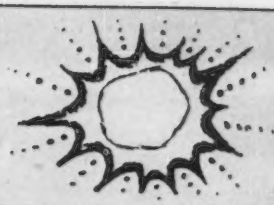
In October 1960, Basic, Inc. completed a multi-million dollar expansion program at its mine and mill site near Gabbs in Nye County. The expansion is expected to increase production by 50% and also to enlarge the number of products. Among improvements are a new refractory mill, rotary kiln, flotation mill, storage silos, and crushing and screening facilities. Also finished are new bagging and warehouse facilities at Luning, 25 miles to the south.

The new rotary kiln weighs 500 tons and is 220 ft long. It is lined with 30,000 bricks and contains instruments which analyze and record burning conditions. The kiln is kept at white heat by using fuel oil, and is used to reduce magnesite briquettes to clinker. The flotation mill is designed to handle 500 tpd and produce magnesite concentrates for kiln feed.

Columbia Iron Mining Co. now has 25 men conducting exploratory work for U.S. Steel Co. southeast of Yerington in Lyon County, but officials say it is too early to report on the area's possibilities.

White Caps mine near Manhattan in Nye County reportedly has ore deposits of a magnitude warranting extensive diamond drilling exploration. About $300,000 has been spent to put the surface plant and

The Getman Brothers' KD-5A Scoot-Crete uses an air-cooled Deutz Diesel.



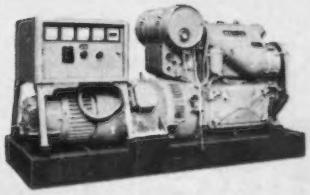
Reason: no warmup needed. Runs effectively from 40° below to 140° above (and it's approved by the Bureau of Mines.)

Fuel goes farther—every drop is burned.

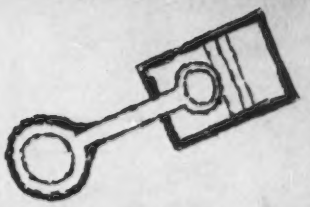
So there's less down time—no sulphurous acid condensation—hardly ever a carbon job.

No water system; maintenance bills go down. You get full H.P. rating; no power lost for cooling.

Good reasons why Wagner ore carriers, Wagner scoopmobiles, the Jones Jackass and the Young Shuttle Buggy run on Deutz Diesels, too.



Deutz air-cooled Diesels are also used on generators, compressors, stand-by power equipment.



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F/A3L 514	48	1800
F/A2L 514	32	1800
A4L 514	72	2000
A6L 514	110	2000
A6L 614	110	2000
A8L 614	145	2000
A12L 614	220	2000
A6L 714	125	2000
A8L 714	168	2000
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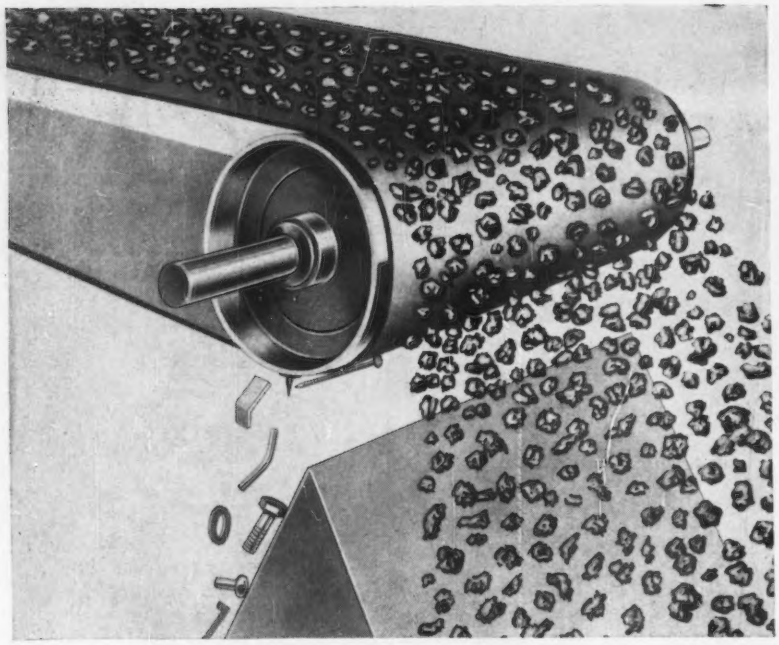

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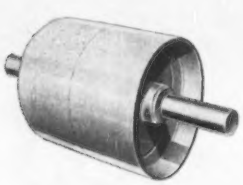

Electromagnetic Pulleys—These powerful, air-cooled pulleys give a dense, uniform magnetic field which is effective on burden depths over 3 inches. Low operating cost, long life, and maximum range characterize this workhorse of the Dings line.

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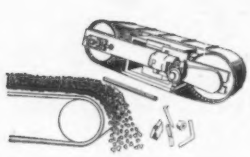

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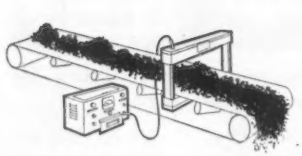

GM-160-½

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Nevada *(Continued)*

buildings in condition and to retimber underground, but future production is expected to run into millions of dollars. The White Caps ore contains values in gold, mercury, and antimony. (Also see California.)

Nevada in October 1960, had 103 mining operations, which is a decrease of seven from the same time last year, according to Mervin J. Gallagher, state mining inspector. Gallagher said Clark County holds the lead with 15 operating mines, while White Pine, with a payroll of 1,498 men, is the leading employer of miners. Less than half the mines in the state are open pit operations, and there are 12 exploration operations and about 26 jobs in progress. The report did not include mines operated solely by owners or lessees.

Business Engineering Co. of Hollywood, Calif., has leased the Eagle Rock Perlite deposits in the Cow Creek area of Pershing county. Construction of a road to the property has begun, and a crushing plant will be erected by spring. Ore shipment will be made from Lovelock. Plans also call for a popping plant to be constructed in the San Joaquin Valley of California to treat the ore.

Nokai Dome Oil, Inc., is producing antimony and silver ore from the Merrimac Mine 19 miles south of Ely. The property is an open-pit operation, and a retort plant is used.

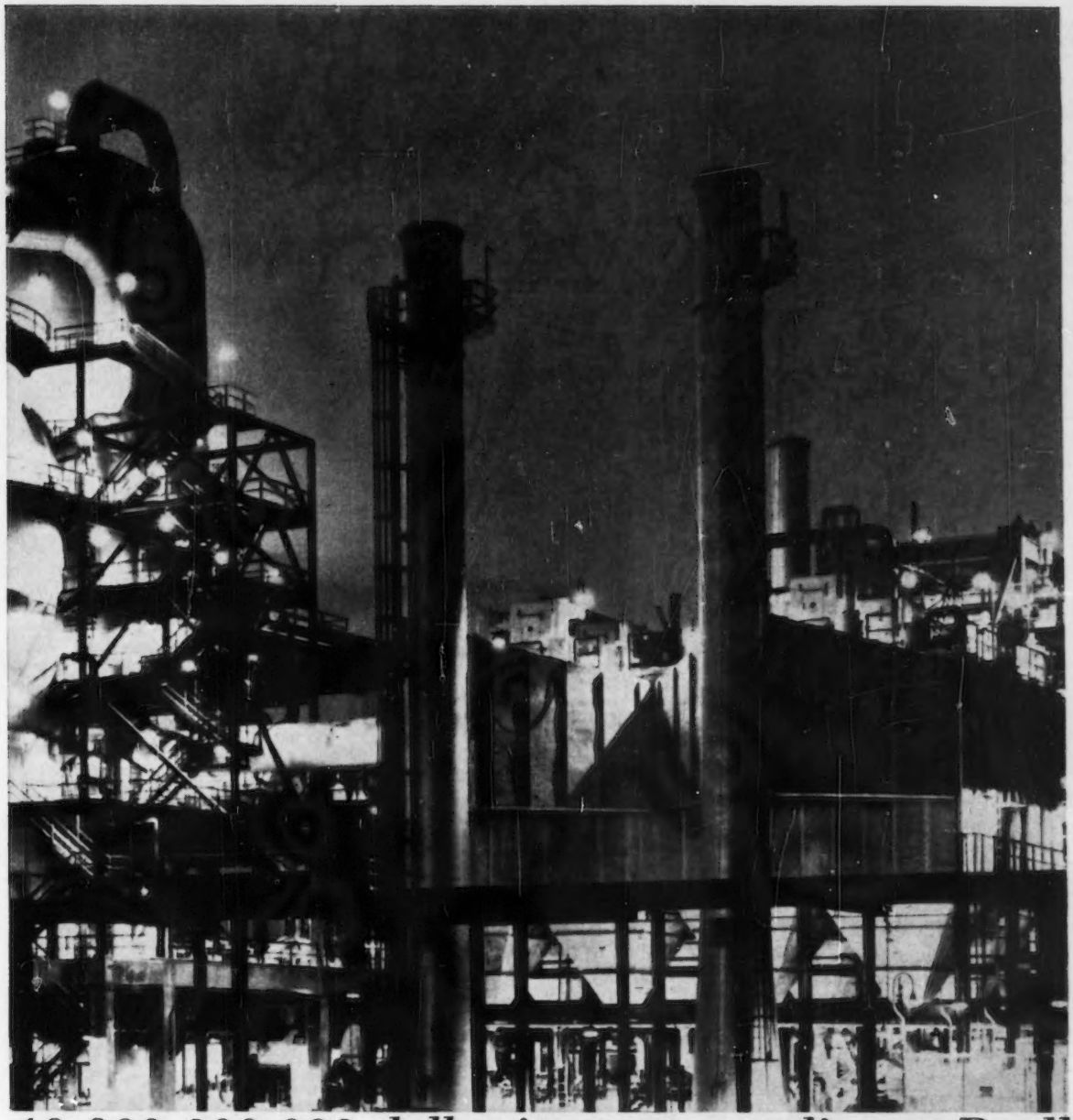
Carson Land and Development Co. of Modesto, Calif., has bought the Tybo mine in Nye County. The sale includes 10 patented claims and two mill sites. The property lies 60 miles northeast of Tonopah, and between 1874 and 1944 it produced 596,040 tons of gold ore which brought $9,789,281. Exploratory work has already been started by the new owners, and production is scheduled for early 1961.

The Gooseberry mine, 15 miles southwest of Fernley, is producing a steady output of good gold and silver ore. Development and exploration work is also going on. Ore is shipped to the U.S. Milling and Minerals Co. mill at Silver Creek by truck.

Belfred Development Co. is producing lead and silver ore from the company's property in the Granite mining district, 28 miles northwest of McGill in White Pine county. A washer concentrator is being used to extract the values.

Work will start immediately at Constant Mineral Co.'s 20,000 acre placer holdings in the vicinity of Rabbit Hole in Pershing County. Work had been discontinued for six years when the U.S. Navy took over the area for a tactical bombing range.

Gold Eagle Mining Co. reports that it has cut into 50 ft of ore-bearing material which assays 28% lead, 19 oz silver, and a small amount of zinc at its Sally Louise mine 40 miles southwest of Tonopah.



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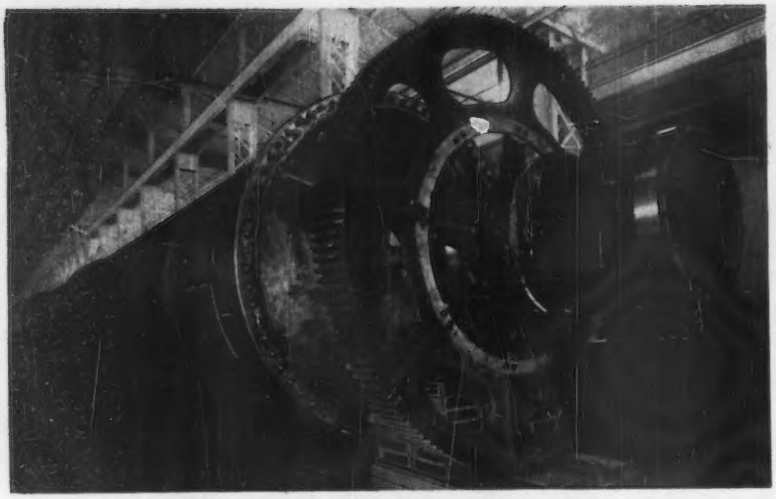

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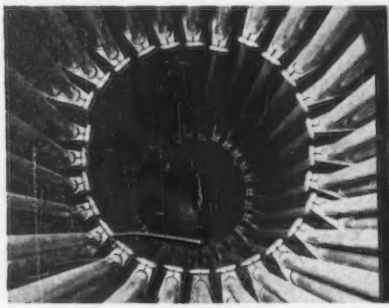
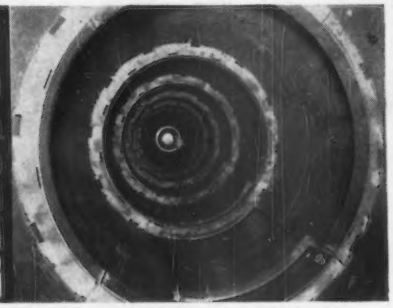
TUBULAR TYPE—Internal water-cooling tubes are assembled with the rotating shell, or installed as a stationary bank of tubes concentric with the shell. Alternately, the water leaving either of these tube sections may be used for supplemental spray cooling on the shell exterior.

DIRECT-CONTACT WATER—For rapid cooling from very high temperatures, water is sprayed directly on the hot material to utilize the latent heat of vaporization. Usually supplemented by secondary air cooling.

Each of these types has a particular area in which it is most economically applied. Write for further information.



Interior of a water-tube cooler. Longitudinal banks of tubes provide maximum cooling surface for minimum floor space.



Interior of partially-submerged cooler with gravity-controlled scrapers maintaining clean shell surface for high-rate heat transfer.

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NORTH CAROLINA

Oil, gas, sulphur and mineral rights under North Carolina's coastal sounds have been leased to Roderick A. Stamey of Houston, Tex., who plans exploratory drilling in the area. The lease agreement, approved by the North Carolina Council of State, allows drilling only in "bottoms" of inland waters.

OREGON

OME has authorized and agreed to pay half the cost of a $14,900 mercury exploration project to be headed by A. O. Bartell, Portland mining engineer. The exploration will be conducted in Clackamas County.

TENNESSEE

Tri-State Zinc Co., a subsidiary of Consolidated Goldfields Ltd., London, has completed a diamond drilling program at their New Market property in Jefferson County. The property was optioned from American Zinc Co. of Tennessee with the provision that a mill be built if a mine is developed. American Zinc Co. is to purchase all concentrates. The diamond drilling program consisted of a series of vertical holes that went to an average depth of 1400 ft. Joy Manufacturing Co. was the diamond drill contractor.

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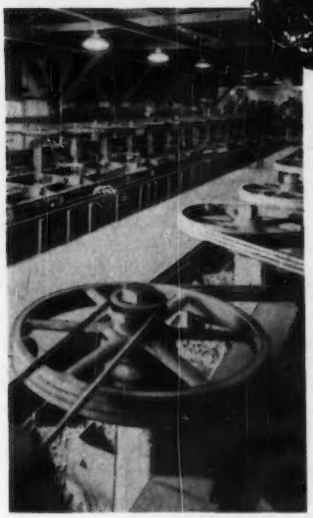

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VIRGINIA

Gov. J. Lindsay Almond has asked the U. S. Forest Service to grant permits for iron ore prospecting in part of the Jefferson National Forest.

Almond said that a survey conducted by the geology department of Virginia Tech had uncovered iron ore deposits rich enough to feed modern electric steel furnaces.

The area where the survey was made lies in Giles County near Pearisburg and Narrows.

The governor reported that E. L. Keesling of Bramwell, W. Va., has already requested a permit to prospect in the national forest.

But he emphasized that he had "been advised that the prospecting itself would have little, if any, harmful effect on the recreational values of the area."

Almond said the state had requested that prospecting be allowed with the understanding that if commercial mining operations prove economically feasible the state would have a further opportunity to express itself on the subject.

UTAH

Texas Gulf Sulphur is sinking a 2500 ft pilot hole on its Moab property in an effort to locate a shaft site for its proposed $30-million potash project. A 7-⅞ in. core will be taken to the 2600 ft level, but drilling will continue on through the potash to 3500 in an effort to determine the composition of ores underlying the potash beds.

WASHINGTON

Clayloon Uranium Co. has made the first shipments of lead concentrates from its new mill at Leadpoint. Officials said the gravity-type concentrator is now in production on a one-shift basis. The concentrates were trucked to a stockpile at the Bunker Hill Co. smelter at Kellogg. Idaho. The smelter at Kellogg has been shut down since May because of a labor strike at Bunker Hill.

The third of four furnaces at the Rock Island plant of Keokuk Electro-Metals division of Vanadium Corporation of America went into operation in the middle of November 1960. Only two of the furnaces at the silicon production facility had been operating since July 1960.

WISCONSIN

A natural gas line from Superior-Duluth to the iron ore fields of Ashland and Iron counties has been proposed by Rep. Alvin O'Konski (R). The Wisconsin Congressman asserted that the primary deposits of iron ore in Wisconsin are rapidly nearing exhaustion, and that processing of large low-grade ore deposits would never get started unless operating costs could be cut.

"Unless Wisconsin can stay competitive, and natural gas would help, there can be no future for iron mining here," he said.

IN CANADA

ONTARIO

Rio Tinto Ltd., London, increased its share in Rio Tinto Mining Company of Canada from 54 to 80% in November 1960. The move involved the purchase at an undisclosed price, of close to 16-million shares from New York financier Joseph H. Hirshhorn. London's FINANCIAL TIMES estimated the money involved at about $11-million, a sum which Rio Tinto of London neither denies nor confirms. Toronto mining circles interpret the purchase as a step by the parent company to obtain complete control of Ontario's Blind River uranium camp, the western world's largest single source of uranium.

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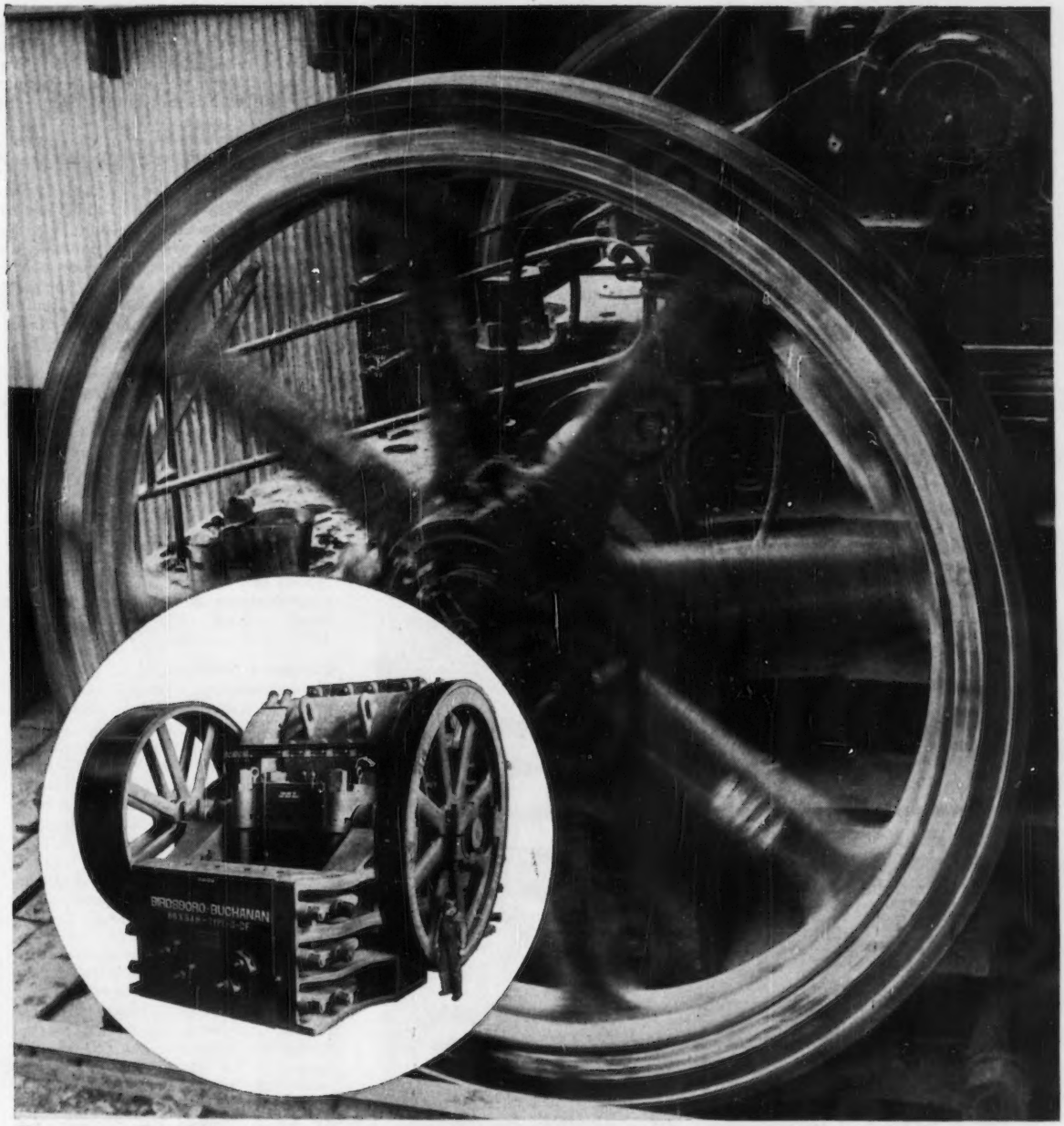

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B. C. (*Continued*)

vately owned company with offices in Edmonton, Alberta, has purchased 44 mineral claims 26 miles southeast of Ross River, Yukon Territory, for an undisclosed amount from R. R. Kirwan, Cassiar. The company has constructed 36.5 miles of access road to the orebody, which consists of massive high-grade lead silver over a measured width of 14 ft on the main surface exposure. High-grade ore shoots increase the overall potential width to well over 100 ft. Selected specimens have assayed over 500 oz Ag and 35% Pb. Average assays of the high-grade material are 80 oz of silver and some 30% of lead.

Officials of Ottawa Silver Mining and Milling Co., Spokane, said the firm will open a new No. 9 level at the company's mine in the Slocan district. The firm expects to double the present five man crew, and plans to do about 300 ft of tunneling. Officials said ore values have been improving on the No. 8 level and some samples have assayed as high as 400 oz of silver per ton.

Toronto's General Engineering Co. has conducted cost studies for Sumimoto Metal Mining Co., Tokyo, which reveal that open-pit mining of Bethlehem Copper Corp.'s Highland Valley property will be feasible by September 1962. The findings give an estimate that $7-million will be required to bring the property into production on schedule. Sumimoto will buy Bethlehem's output over a 10 year period, provided it agrees to furnish funds to put the property into production at 3,000 tpd, and raise this figure to 5,000 tpd in two years.

Bralorne Pioneer Mines, Ltd., reports that gold production jumped 30% during summer, 1960, despite a shutdown in mid-August. This rise was due to greater tonnage through-put and unexpectedly high-grade mill feed, which averaged 0.8 oz compared with the previous diluted reserved grade of 0.75 oz.

Contracts have been awarded for construction of two line drives at the Wells property of Cariboo Gold Quartz Mining Co., Ltd. The drives will cut 125 ft above and below the 3,000 ft level of the new Burnett fault zone. The company estimates that the upper cut will run 900 ft before it hits the orebody while the lower drift will require 3,600 ft of tunnelling. Work is expected to move at 500 ft a month. Dr. W. B. Burnett, president, reports that the new orebody is a "very close duplicate of the Aurum fault zone which is continuing to yield 1,500 to 1,700 oz of gold monthly."

Craigmont Mines, Ltd., is expected to begin production of copper concentrates at its Merritt Property by the end of 1961. The site for a 4,000 tpd mill has been excavated, and Inland Natural Gas Co. has signed a contract to supply natural gas to the property starting about February 1961. Craigmont is being developed by the Canadian Exploration, Noranda Mines, and Peerless Oil companies. The property contains reserves of 17.6-million tons of ore averaging 2.08% Cu, and will be the scene of the first such undertaking in many years.

Canam Copper Co. expects to hit its orebody at the end of a 6,000 ft adit within three months, according to G. H. Hefferman, company spokesman. The property has some 3¼-million tons of commercial copper ore. All facilities and equipment for putting the mine into production, except a mill, are on the property. It is expected that Mogul Mining, which controls the company, will provide for a mill.

Mines Minister Kiernan has stated that, despite reports to the contrary, exclusive mineral prospecting reserves have been set up, not to favor companies or groups, but primarily to avoid the "unwitting staking of claims in areas of potential hydro development."

A panel of delegates to the Canadian Institute of Mining and Metallurgy's annual western meeting in Vancouver concluded that Japan holds the greatest promise as a major importer of Western Canadian mineral products in the next ten years. According to a representative of the Mitsubishi Shoji Kaisha Co., Japan's long-range needs will include iron ore, coking coal, liquid gas, potash, asbestos, and gypsum.

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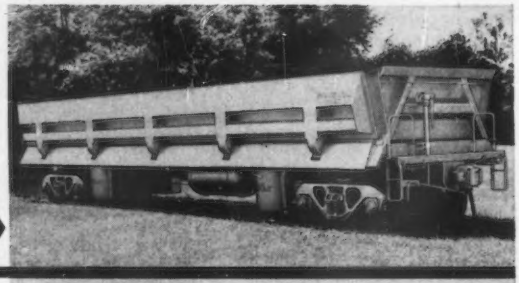

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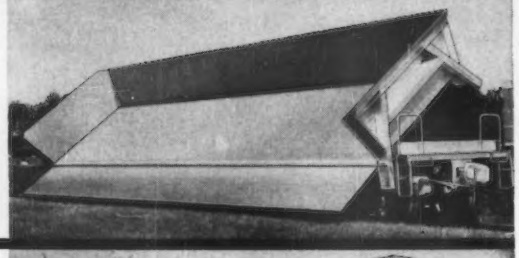
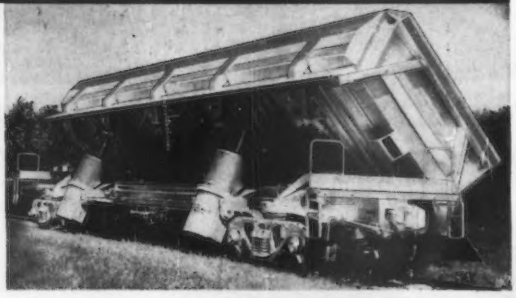


Floor massively reinforced. Door operating mechanism under floor and protected from damage. Hardened and lubricated pins and bushings insure correct functioning and negligible wear.



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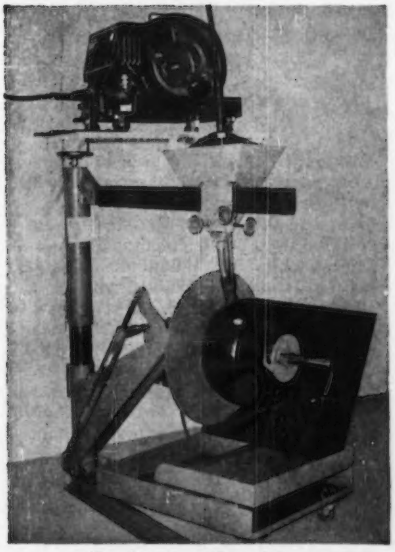
Shovel roll as rebuilt with Stoody wires.



Semi-automatic welder with positioner.

Don't throw worn shovel rolls and similar parts on the scrap heap! Rebuilt and hard-faced with Stoody alloys, such parts are as good or better than new—at a fraction of replacement cost.

Rebuilding is fast... by the semi-automatic or the full automatic welding processes. With the semi-automatic welder a simple positioner is used as shown at the left. The welder is a versatile machine that can be used either with the positioner or manually in the usual way as illustrated below. Investigate the semi-automatic; it does more work in less time, reduces replacements, soon pays for itself.

Your Stoody dealer will be glad to direct you to custom automatic shops or to demonstrate the semi-automatic in your own shop. Run the machine yourself... test it on your own rebuilding and hard-facing jobs.

See the "Yellow Pages" in your phone book for your local Stoody dealer or write for his name and address. Completely illustrated folders on all Stoody wires are available.

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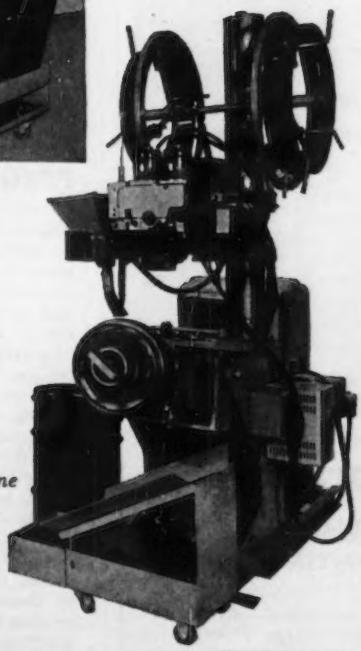

Automatic welding machine rebuilding a shovel roll.

Typical manual semi-automatic operation, open arc.

IN LATIN AMERICA

CHILE

The Japanese firm of Mitsui Bussan Kaisha, Ltd., recently formed a Chilean company known as Mitsui-Chile, with a capital investment of $100,000. Mitsui Bussan has been exporting copper cement, concentrates and ores to Japan for almost two years. It has also bought mines and a small leaching plant at Antofagasta known as Andromeda y S.A. Portezuelo.

Chile's Secretary of Mines has predicted that, for every cent the price of copper falls, the Chilean Treasury will lose $6-million in revenue per year. He also stated that Chile's copper production for 1960 would total 550,000 short tons.

CORFO, the Chilean equivalent of the RFC, has arrived at an agreement with the Empresa Nacional de Mineria (formerly the Mining Credit Bank) to invest about $500,000 to help develop mining in the Provinces of Tarapaca and Antofagasta. Of this total, $268,500 will be spent investigating mining resources of Iquique, Tocopilla, Taltal and Antofagasta. Some $111,500 will be used to construct two 35 tpd mills at Taltal and Tocopilla. Total investment in the mills, including the contribution of the Empresa Nacional de Mineria, will be $250,000. The same organization will also build a 100 tpd fine-crushing plant at the town of Antofagasta.

The ExImBank has conceded a loan of $15.6-million to Cia. de Acero del Pacifico, owner of the Huachipato 400,000 tpy steel mill in southern Chile, for the development of the 100-million ton, high grade iron ore deposit of Algarrobo, near Vallenar, Atacama Province. The ore from the Algarrobo mine will be shipped both to Huachipato and to Europe from the port of Huasco, where a modern ore-loading wharf will be built. The port of Huasco will be linked to the Algarrobo mine by a railroad.

Cia. Minera Disputada de Las Condes, now controlled by Penarroya, is going ahead with its several projects to raise the capacity of its mill to 9,000 tpd of iron ore. The program, which will include construction of a new mill, will take several years to complete.

MEXICO

George H. Jett, independent oilman from Shreveport, La., is reported to be part-owner of a large iron-mining concession in the state of Colima on Mexico's northwest coast. The property is said to contain some 100-million tons of high-grade ore. All production will, according to the terms of the concession's contract, have to be consumed in Mexico. In order to export, Jett and the company (called Minera Ducro, S.A.) would have to put in a blast furnace, and this possibility is considered doubtful by Mexican mining experts. Without exports, it is unlikely that production will warrant extensive railroad and port facility construction.

PERU

Mitsui Bussan Kaisha Ltd. has taken an option on the San Jose copper property, 37 km south of Arequipa. The property, held by Antonio Tord Gomez and others, is a low-grade porphyry copper deposit. Unproven reserves are estimated between 250-million and 500-million tons of 0.6% ore or less. Both Cerro de Pasco Corp. and Kennecott Copper Corp. have held options on the San Jose property carrying out exploration work, including diamond drilling.

The Mitsui company, operating one of the largest copper smelters in Japan, also holds an option on the copper mine of the Cia. Minera Chapi, a few miles south of the San Jose property. Chapi's proved and probable deposits are said to be about 80,000 tons of 3.5% ore with prospective deposits estimated at over 1-million tons.

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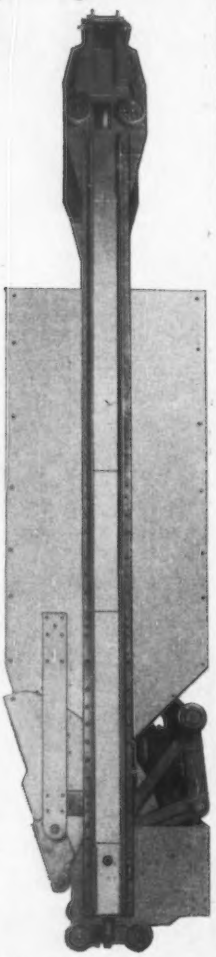

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- The Connellsville Bottom Discharge Skip is always vertical—does not move horizontally to discharge. Instead, the chute swings out over the receiving hopper to discharge material quickly and accurately.
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Bulletin No. 100 entitled "Shaft Production Equipment" gives additional details on other Connellsville Skips and Loaders. Ask for it.

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IN AUSTRALIA

A large deposit of limonitic iron ore has been discovered near Augusta, 200 miles south of Perth, by Griffin Coal Mining Co. Initial estimates claim a content of 60 to 100-million tons of ore averaging 45% iron. Japanese experts are assisting in the examination of the deposits.

Informed Australian circles believe that the ban of Australian exports of iron ore to Japan will be at least partially relaxed in the near future. Both the West Australian authorities and mining interests are pressing the government for permission to start substantial exports.

The Asarco-controlled Mt. Isa Mines, Ltd., has decided to revise its expansion program and to reduce its mining tempo. Fluctuating metal prices, increased Australian wages, and taxation are being blamed for the decision, which covers expansion both at Mt. Isa and at the Townsville copper refinery. Group sales of Mt. Isa Mines rose by approximately $16.8-million in 1960, setting a record high of nearly $63.8-million.

Australian gold mining experts reportedly feel that new exploration and resumption of work in abandoned mines is not now feasible, due to high mining costs.

IN AFRICA

The Government of Southern Rhodesia has agreed to remit royalties on 1960 asbestos production from the Slip Mine and the Bend Mine, both operating in the Bulawayo mining district. Rhodesian Vanadium Corp.'s chrome output in the Salisbury area will also receive the same concession.

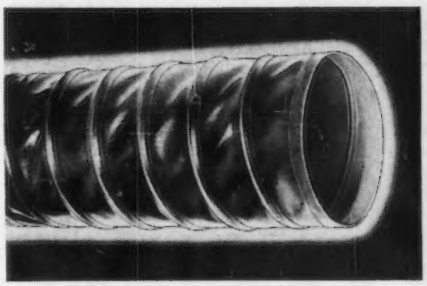
Because of over-supply in the copper market and a drop in prices, Anglo-American Corp. and Rhodesian Selection Trust groups on the Northern Rhodesian Copperbelt have agreed that each will cut production by 10%.

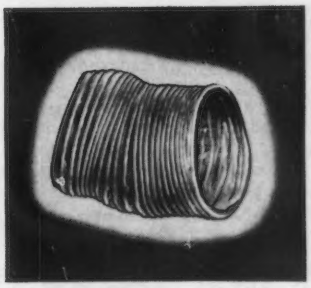
The underground water seepage which once threatened the development of several Orange Free State gold mines is being curbed successfully by continuous pumping. At the Harmony Mine, a Central Mining-Rand Mines property in the Virginia area, the quantity of water pumped out dropped from 5-million gal per day in June 1959 to 4.5-million in June 1960. Water pumped at the St. Helena mine has shown a downward trend despite an extension in the underground workings.

Mine technicians expect that the thick lava layer above reef formations will prevent water from reaching the workings by seepage from the surface, and that the pumping may eventually empty the fissures below the lava beds.

Because of difficulty experienced in production of payable gold ore, the milling

It's here . . . New ABC Mine Duct wire reinforced ventilation tubing





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Africa (*Continued*)

rate at Modder East, East Witwatersrand, has been reduced from 130,000 to 52,000 tpm. About 2750 miners were expected to be laid off in December.

Recent shaft development at Western Areas mine, in the Carletonville area of the West Witwatersrand, has exposed "highly encouraging" gold ore values. Acting on this indication, General Mining and Finance Corp. is about to begin gold prospecting in territory to the east of Western Areas mine. Johannesburg Consolidated Investment Co. is already prospecting in the area.

Records for monthly mineral production in Southern Rhodesia have again been beaten. The value "at mine" of mineral production for September was almost $280,000 more than the previous high. Total output value for the first nine months of 1960 is over $54.88-million, as compared to $51.8-million for the first nine months of 1959. Chief increases are in chrome, copper and tin, and asbestos, gold and coal have kept up with 1959 figures.

Northern Rhodesia also showed an increase in mineral production in the first eight months of 1960 of at least $14-million above the same period in 1959. Principal minerals mined were blister copper, electrolytic copper, zinc, cobalt, and lead.

Negotiations have ceased between Japanese interests and the Anglo-Transvaal organization concerning proposed construction of a nickel smelting plant near Bindura in Southern Rhodesia. Anglo-Transvaal will continue its prospecting and drilling activities in the area.

Consulting engineers have been investigating a plan for improvements and extensions to Consolidated Copper Mines' leach plant at their Northern Rhodesian open-pit property. Preliminary estimates show that extensions costing between $5.5 and 8.5-million should raise copper output by 15,000 tpy without an increase in the mining rate.

Leaders of the Northern Rhodesia Mineworker's Union have presented their eight branches with a plan by the Mining Joint Industrial Council to abolish separate categories of jobs for European and African copper mine workers. It is proposed that there should be one ladder of promotion from the lowest job to the highest and that advancement should depend entirely on competence and character.

National Science Foundation has awarded Professor Eugene N. Cameron, of the University of Wisconsin geology department, a $29,000 grant which will enable him to continue basic research on South Africa's chromium ore deposits.

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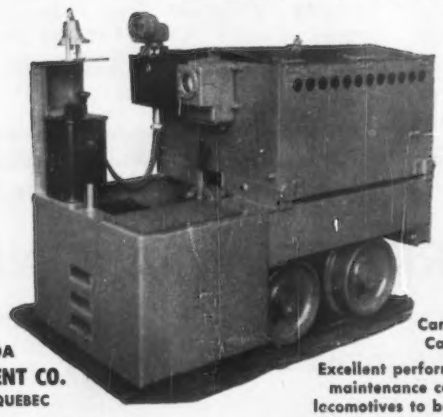

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IN EUROPE

ITALY

As a result of negotiations with the European Common Market, Italy's lead and zinc production is to get customs protection for a period of six years in order that Sardinia's industries may proceed with a large scale development program, and may eventually enter the competitive international market.

Details of the development program were discussed recently at Cagliari. Those taking part in the discussions were representatives of the Monteponi Co., of the Pertusola Co., of the Montevecchio Co., and of the state controlled AMMI (Italian Mineral Metal Co.). A total investment of $27,200,000 is planned by the firms taking part in the program, this sum to be appropriated to the mining and metallurgical industries. With regard to the latter, AMMI has announced plans, which are already at an advanced stage, for the construction of a plant to produce zinc metal. The plant will be situated on the western coast of Sardinia and will be able to handle the zinc deposits mined in the immediate vicinity. The new plant will also be close to the huge thermoelectric power plant of Carbonia, at present under construction.

It was stressed at the meetings that, in view also of the precarious nature of the mining industry, the firms taking part in the development program would need financial aid from the Government.

FRANCE

Societé des Acieries de Pompey, one of the leading French producers of special steels, will apply a process of liquid fuel-oil injection to its entire pig-iron production. The process will raise blast-furnace production by from 10 to 20%, and also decrease coke consumption.

RUSSIA

According to Tass, Moscow specialists have developed a "jewelry alloy" of Au, Cu, Mn, Ni, Zn, and Cd. The alloy is said to have the hardness of steel and the malleability of gold.

IN THE PHILIPPINES

Manila Mining Co. reports that two new gold veins have been discovered on the company's property in Aguson, Mindanao. It is said that one of the veins averages better than one oz for over 300 ft strike length. The company is also developing disseminated copper deposits in the same area.

Atlas Consolidated milled 254,000 tons of 0.58% copper ore at its Toledo mine in September 1960, and produced 2,582,000 lb of copper. From its iron mine in Davao, 9300 metric tons were shipped to Japan. Philex Mining Corp. milled 5500 tons of copper ore at its Santo Tomas plant in September 1960, with metal content estimated at 662,500 pounds of copper.

In September 1960 the Itogon-Suyoc mines in the Baguio area produced 4145 oz of gold. The Itogon mine accounted for 44% of output, and Suyoc 56%. Average grade of the ore was about $7 per ton.

CORRECTION

In the August issue on p 156 E&MJ mentioned that Aristotle S. Onassis, Greek ship owner and J. Paul Getty, U.S. oilman, were to develop a 10,000-acre tract of potential iron ore property along the north shore of Quebec's Saguenay River.

Since that time, E&MJ has learned that neither Mr. Onassis nor Mr. Getty are, or ever have been, interested in the mentioned Quebec project, and that Mr. Getty never has had any financial interest in, or connection with, Commonwealth Getty Mining Co. of Canada.

LETTERS

I have problems and I need help—maybe someone in your audience can give me an idea.

I need details, plans, specifications, and description of operation of a simple lead smelter. The installation I have in mind went out of use in this country so long ago that published descriptions are not easily located.

My interest in primitive smelter operations stems from a trip I made to North Sumatra shortly before I left Indonesia. (See "personals," this issue.)

A young Army officer, Captain Albert, came to my Djakarta office seeking advice and help to develop a lead prospect located deep in the jungles of North Sumatra.

It transpired that Captain Albert represented the mineral development section of a special task force created by the Indonesian Army command to develop enterprises capable of furnishing jobs and support to honorably discharged veterans.

I put in three weeks with the Captain and his staff examining every mineral occurrence in his area. Nothing of interest turned up, but I came to view the group's effort with a sympathetic eye when I learned the Captain considered his operations as a training exercise pending opening of more favorable areas. Practically all known commercially important mineral occurrences on Sumatra are closed to exploration by rebel activities—so, pending resolution of political differences, the Captain is forced to concentrate on training a cadre of future foremen. Then, too, he wants to make some lead if possible. He has no illusions about exporting ore, concentrate, or lead.

The prospect the Captain was trying to develop proved to consist of lead

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Letters *(Continued)*

sulfide float mixed with surface overburden that is twenty feet thick. No exposed rock in place is in the immediate area. It looked like about a thousand tons of float and a poor chance of amounting to much else.

I laid out an exploration program designed to expose solid rock in the vicinity of greatest concentration of float and left the Captain and Indonesia with the promise to help in any way possible.

Just recently, Captain Albert sent me a sketch of a Heath furnace he would like to erect near his mine. The installation depicted shows a furnace unit with six brick spray chambers. I don't think the prospect warrants as elaborate an installation as proposed, but I must come up with a complete substitute if I hope to sell my ideas. The enthusiasm and objectives shown by Captain Albert and his staff demand all the support I can give them.

Philip W. Simmons
Office of Industrial Resources, ICA
Washington, D.C.

We wish to thank you for the write-up in your November 1960 issue of E&MJ (p 20).

Unfortunately, there is a misprint or there was a misunderstanding. The article reads "no stainless steel or rubber lined equipment to produce 70 to 80% yellow cake from the 0.6 to 0.7 ore." This should read "0.06 to 0.07." In other words, six to seven hundredths ore rather than six to seven tenths ore. This article would lead people to believe that we required a rather high-grade ore to accomplish our process.

A. Hack
President, Hack Engineering Co.
Denver, Colo.

In your September 1960 "Beryllium issue" you stated (p 99) that the berylometer is "manufactured and sold in the U.S. by Nuclear Corp. of America's Western Division at Burbank, Calif." Actually, this meter is a product of the Isotopes Specialties Co., which is a division of Nuclear Corp. of America.

Dr. Kenneth W. Newman
General Manager,
Isotopes Specialties Co.
Burbank, Calif.

On page 158 of the October issue, there is a report of our activity in the Sawtooth Mountains area of Idaho.

A regrettable implication is given that the Idaho beryllium investigation is being carried on by our state Bureau alone. Such is far from the truth, for the beryllium investigation is a cooperative project between the U.S. Bureau of Mines and the Idaho Bureau of Mines and Geology. Geologists and engineers of both Bureaus have been in the Sawtooth area on this project.

As for the last sentence, I did not say quite what is attributed to me. To the Salt Lake Tribune I said we (meaning both Bureaus) *hoped* to do more extensive work in the Sawtooth region next year, including sampling. As you know,

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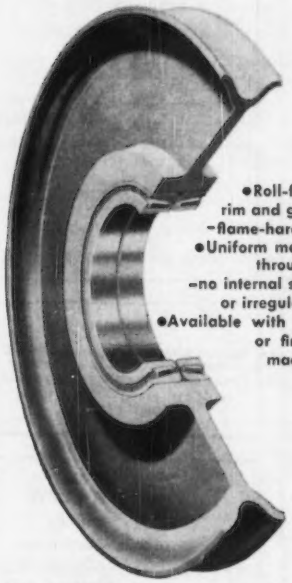

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Letters *(Continued)*

passage from the hoping to the planning stage in government work is over the bridge of appropriations. We do not yet know what funds will be available for 1961 work.

Incidentally, I believe the project of which I have been writing is the first of its kind. There have been cooperative projects between the U.S. Bureau of Mines and state agencies, of course, but they have generally required one agency to do the field work, the other the lab work. Ours is primarily a field project using a combined crew, the geology and petrologic studies being done by the Idaho Bureau, the sampling and evaluation being carried out by the U.S. Bureau. We now have in effect a second cooperative project of this same nature, an investigation of iron ore resources in Idaho. We value the cooperative agreement under which we are operating, for we think it will work out to the benefit of our state.

E. F. Cook
Director, Idaho Bureau of Mines and Geology
Moscow, Idaho

In my article on possible applications of "Ultra-Hot Plasmas" in extractive metallurgy in the October issue, editorial changes were made which should add to readibility. However, I must call attention to an error injected in a sentence which appears at the top of the third column on page 113.

To illustrate the extraordinary concentration of energy in a plasma jet, I made the statement that "anode diameter for a plasma jet may range from ½ in. for a 40 kw unit to 3 in. for a 3,000 kw unit; while in the Hall cell, the cathode normally absorbs not over 5 kw per sq ft." Following this statement, however, the editors added, "Thus an area the size of a dime handles eight times as much power as a surface roughly the size of this page."

Compared with the aluminum reduction cell absorbing not more than 0.0347 kw per sq. in. (5—144), the plasma jet, according to my figures, takes from 204 kw for a ½ in. unit (40—0.196) to 424 kw for a 3 in. unit (3,000—7.07).

Your page is roughly 8 by 11 in., and 88 sq in. times 0.0347 would be only 3.05 kw. A dime measures about 0.7 in., and its areas of 0.385 sq. in. times 204 kw would be 78.6 kw; times 424, it would be 163 kw.

According to my figuring, then, the correct multiple, instead of eight, should be in the range of 25.8 (78.6—3.05), or 53.4 (163—3.05).

Although the dime-page comparison is dramatic, my atavistic engineering mind would favor a comparison showing that the concentration of energy per sq in. may be at least in the ratio of 0.0347 (Hall Cell) to 424 (plasma jet) in a large unit, or 10,000 to 15,000 times as great.,

Paul M. Tyler
Mining Engineer and Metallurgist
Washington, D. C.

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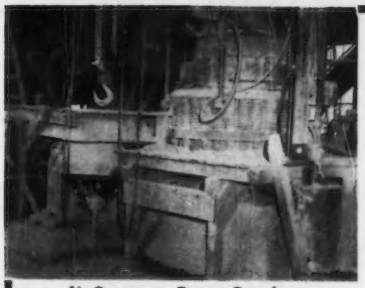

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1—8 cu. ft. Bucyrus Erie Bucket Line, w/ Pan. Am. Jigs, trommel screen.

FEEDERS
1—4" x 8' Jeffrey Vibrating Type 5, 440 V.
1—3' x 6' Jeffrey Traylor Grizzly Pan, 440 V.
1—36" x 8'4" Link Belt, Apron type, ½" Pans.
1—48" x 8' Link Belt Apron Feeder, type B.
2—60" x 15' e to e Heavy Duty Apron Feeders, with motors.
1—30" x 13' Belt Ore, like new, 1½ HP.
1—36" x 15' Link Belt, apron, 5 HP.

FILTERS
1—6' 5 DISC American complete
1—4' 2 DISC EIMCO ½ H.P. Reeves Varidrive
1—6' 6 DISC EIMCO with accessories
1—8' dia. x 8' Morse Bros. Drum type, less motor & drive
1—11½' dia. x 12' Oliver Drum type, complete.

FLOTATION MACHINES
1—6 cell #21 Denver "Sub A" Flotation
1—1 cell #100 Denver Unit Cell
3—2 cell Size 14-S, 56" x 56" Fagergren, 10 H.P.
2—2 cell Gallagher Agitair, 48" x 48", 10 H.P.
1—3 cell #18 Sp. 32" x 32" Denver "Sub A"
4—6 cell #18, 28" x 28" Denver "Sub A"

HOISTS, MINE SHAFT
1—10 H.P. Coeur d'Alene, Single Drum
1—40 H.P. Coeur d'Alene Jr. Single Drum
1—50 H.P. Superior Lidgerwood, Tandem Drums, 220 V.
1—75 H.P. Puget Sound Single Drum, Post Brakes
1—600 H.P. Vulcan Wilkes Barre, 2 drum, 2300 V.
1—675 H.P. Vulcan Wilkes Barre, 2 drum, 2300 V.
1—165 HP. Denver Eng. Works, 2 drum, 440 V.

HOISTS, TUGGERS & SLUSHERS
1—BF 312 Joy, 3 drum, 20 H.P. 440 V.
1—FF311 Joy, 3 drum, 10 H.P. 440 V.
7—FF211 Joy, 2 drum, 10 H.P. 440 V.
2—30 NM3D Ing. Rand, 2 drum, 30 H.P. 440 V.
1—20 NM2C Ing. Rand, 2 drum, 20 H.P. 440 V.
1—CA 311 Sullivan, 3 drum, 50 H.P. 440 V.
1—CF 211 Sullivan, 2 drum, 50 H.P. 440 V.
10—HB Gardner Denver, 1 drum, Air
8—L-111 Joy, 1 drum, Air
10—A5NNOH Ingersoll Rand 3 drum, air.

JIGS
2—16" x 24" Denver duplex, 1½ HP.
1—12" x 18" Denver duplex
1—42" x 42" Bendalari Simplex
2—26" x 26" Bendalari Simplex

LOCOMOTIVES
8—1½ Ton Mancha battery, 18"-24" ga. Complete
1—1½ Ton Atlas, Type J, 24" ga. w/charger.
1—3½ Ton Mancha Type AN, Battery, 18" ga.
1—5 Ton Mancha, Titan A, bttery, 24" ga.
1—4 Ton Mancha, Std AN, battery, 24" ga.
1—7 Ton Plymouth diesel, w/scrubber, 18" ga.
1—8 Ton Plymouth diesel, w/scrubber, 24" ga.

MILLS
5—8' x 9' Traylor Ball Mills, 250 H.P. motor
3—5' x 14' Marcy Ball Mills, 100 H.P.
1—6' x 16" Hardinge Conical, 50 H.P.
1—4' x 5' Colorado Iron Works, 30 H.P. 440 V.
1—7' x 36" Hardinge Conical, 100 H.P.
1—7' x 22" Hardinge Conical, 75 H.P.
1—7' x 5' Allis Chalmers, 150 H.P.
1—7' x 48" Hardinge Conical, 150 HP. motor

MUCKING MACHINES
1—12B Eimco Rocker Shovel, Late Serial, 18"-24" ga.
5—GD9 Gardner-Denver 18" ga.
1—HL3 Sullivan, 18" ga. bargain
2—21 Eimco Rocker Shovel, 24" ga.

SCREENS
1—4' x 9' Deister Plato, 1 deck, 7½ H.P.
3—4' x 12' Tyler Ty-Rock, F600
1—4' x 10' Tyler Hummer, 1 deck
1—4' x 8' Symons Rod Deck
3—6' x 14' Hewitt-Robins Heavy Duty Scalping Screens

SHOVELS
1—7 yd. Bucyrus Erie, 170 B, electric
1—3½ yd. Marion 111M, with Dragline
1—20B Bucyrus Erie Shovel, with 40' Dragline
1—54B Bucyrus Erie with dragline

THICKENERS
1—15' x 8' Denver Rake Thickener Less tank
1—38½' x 8' Denver Spiral Rake w/steel tank
1—120' Dorr Traction Type 1-C, 5 H.P.
2—40' Dorr Thickerener Mechanisms, 2 H.P.
4—20' Dorr Thickener Mechanisms, 15 H.P.
2—30' Thickeners, completed wood tank, 2 HP.

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14—60 cu. ft. C.S. Card Granby, 18" ga.

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2—1075 cfm Ingersoll Rand Model 6XVO, with Diesel Engine

CRUSHERS
1—4' Symons Cone Crusher, 100 H.P. 2200 V.
1—24" x 36" Allis Chalmers, Blake Type, 75 H.P.

FEEDER
1—42" Ross Chain, with 2 H.P. motor, 440 V.

FILTERS
1—6'-4 disc American disc type, complete
1—6'-8 disc Eimco Disc type, complete

LOCOMOTIVE
1—3 Ton Jeffrey Trolley, 18" ga. 250 V.D.C.

MAGNET
1—32" dia. Stearns Suspended, 125 V.

MILL
1—5' x 12' Marcy Rod Mill, 125 H.P. 2200 V.

PUMPS
1—6" Ingersoll Rand Deepwell Size 10APH-1, 220/440 V.
1—6" Worthington Deepwell, Size 6-16QE-4, Johnson gearhead.
1—2" Denver Diaphragm, Simplex
3—6" Denver Diaphragm, Simplex
3—2" Wilfley Sand Pump, 5 H.P. 440 V.
1—3" Wilfley Sand Pump, 5 H.P. 440 V.

SAW
1—34" dia. Circular Timber, Insert teeth, 15 H.P. 220/440 Motor
1—30" dia. Swinging cut-off, 10 H.P. 440 V.

THICKENER
1—40' dia. x 6' deep Denver Spiral Rake, steel tank, 2 H.P.
3—40' dia. x 10' deep Denver Spiral Rake, steel tank, 5 H.P.

WEIGHTOMETER
1—18" Merrick Model E, recording device 25 TPH

WELDER
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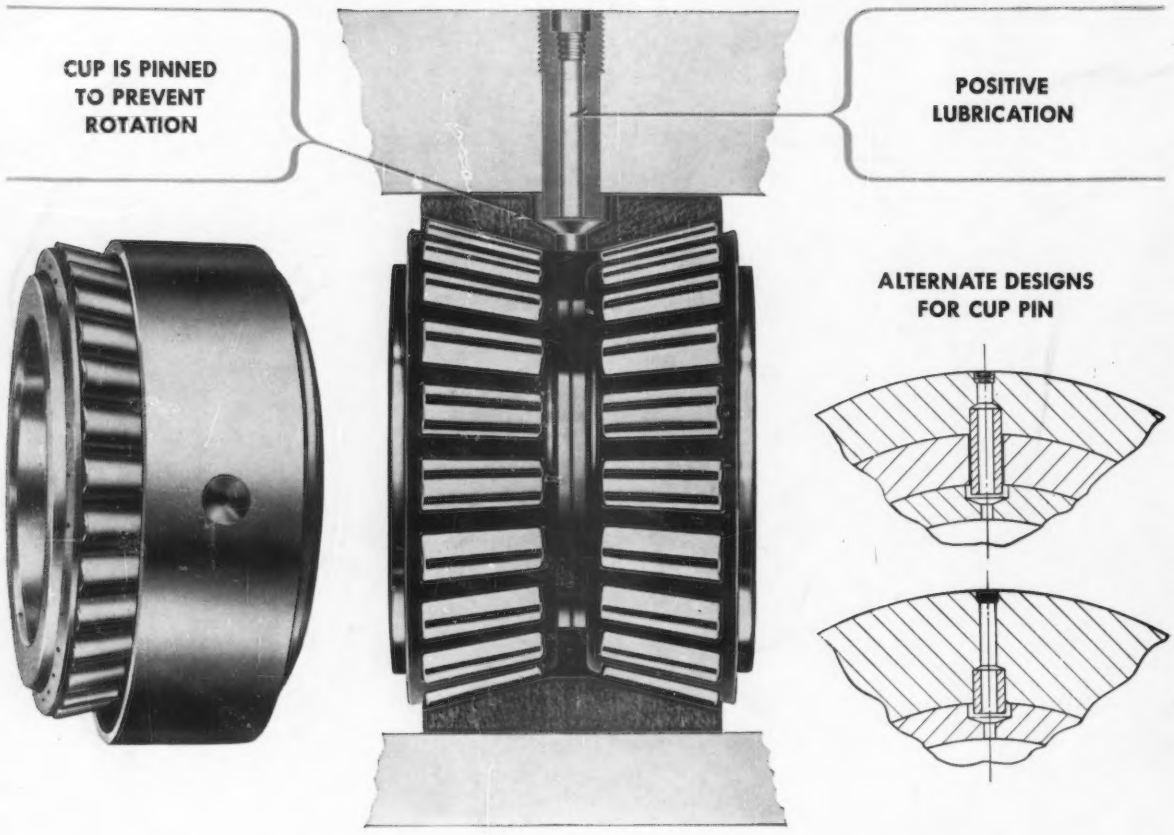

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